POWER

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The Steam Engine Indicator

THE "much abused instrument" as it has been facetiously called.

Has it really seen its day?

How many a steam engineer owes the awakening of his interest in the refinements, the technical side of his calling to its use and the study of its revelations!

How many a man I have seen who knew nothing but the simple manual processes of his vocation led by his study of the indicator diagram to the knowledge of steam and its properties, of engines and their possibilities, of valve motions and their complexities.

How many have worked themselves up, by the economies that they were able to effect by its intelligent use and by the thinking, reasoning powers that its use and deductions therefrom developed, to higher attainments and better positions!

We do not see or hear so much of it now. The blackboards of the engineers' associations that were wont to be decorated with indicator diagrams are filled with the windings of electric generators and motors and the details of steam turbines.

But there is vastly more power generated today by steam than there was when "Twenty Years with the Indicator" appeared.

And not all of the increase is generated by turbines, steam and water both.

There are still a lot of steam engines, large as well as small, that can be made to do their work better and more economically by letting the indicator show what is going on inside of them.

The use of electricity as a method of transmission and the consequent possibility of measuring the amount of work done by the engine by the simple wattmeter has taken from the indicator one of the large services that it used to perform—the measurement of power.

But there are a lot of new and increasing uses for it. The internal-combustion engine has challenged it with problems that its designers and makers have satisfactorily met. Applied to the gas or hydraulic ends of compressors and pumps, its indications are still valuable in power measurement as well as in showing the functioning of valves and the behavior of the medium.

There are plenty of chances still for the indicator and for men who know how to use it.

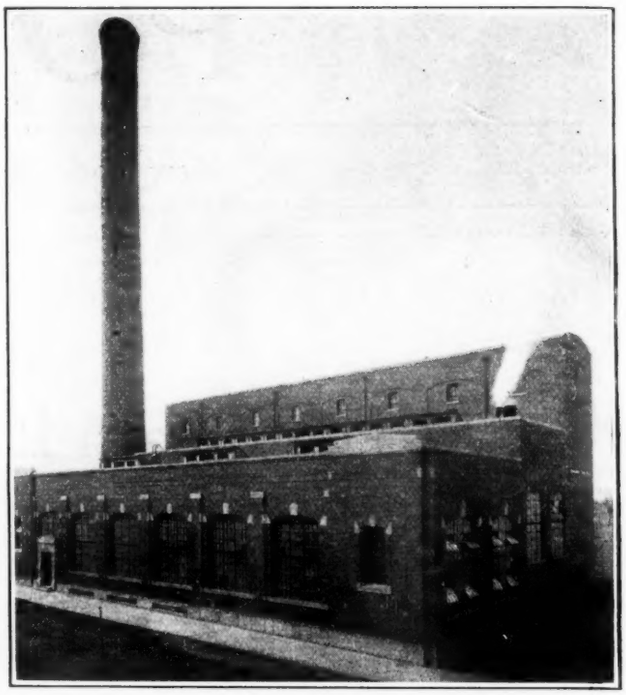
F. R. Low

Wayne County Infirmary and Hospital Plant at Eloise

GROWING requirements of the county institution called for a new power plant. Maintaining service during the construction period and balancing the steam and power demands were the chief problems encountered.

AT ELOISE, Mich., Wayne County maintains a combined infirmary and insane hospital administered by a board of seven members, known as the Wayne County Superintendents of the Poor. At the present time the institution has a capacity for 3,600 inmates and consists of 56 buildings, including hospitals, infirmaries, administration building, bakery, laundry, cold-storage warehouse, carpenter and plumbing shops, etc.

As will be anticipated, large quantities of steam are required to supply the various services. For heating, 200,000 sq.ft. of equivalent direct radiation is installed. In all the old buildings radiators are used, but buildings erected within the last ten years are equipped with split systems of heating, hot blast systems being used to heat the strong rooms of the insane hospitals. The direct radiation aggregates 160,000 sq.ft., and the indirect surface in the fan coils makes up the remainder of the total figure given. High-pressure steam is supplied for all kitchen and laundry work, and from the same high-pressure steam main, live steam reduced to 5 lb. pressure is taken for the fan coils. All direct radiation is fed from the exhaust mains at a pressure of 2 lb. Vacuum pumps return the condensation to the power house.



Wayne County Eloise power plant

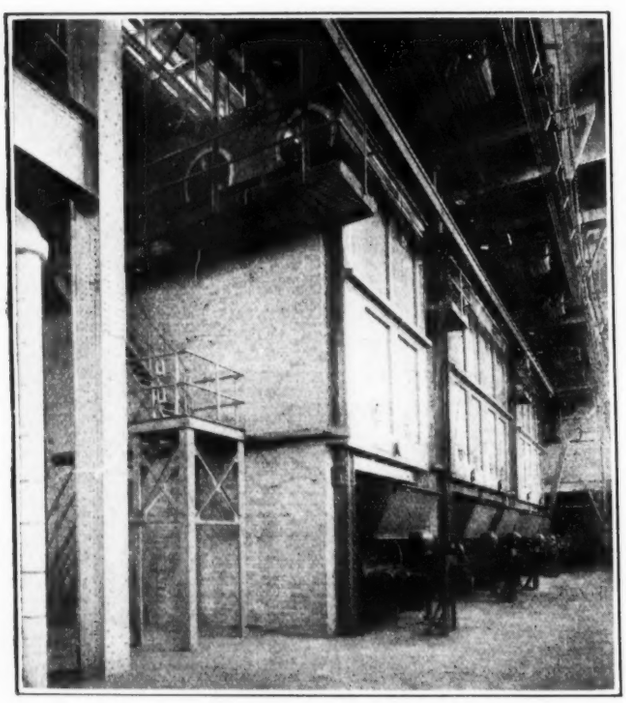


Fig. 1—View along firing aisle in boiler room

In the old plant electrical energy was supplied for lighting and for power used in the cold-storage plant for driving the compressors and brine pumps, in the carpenter and machine shops and bakery and for water pumping, elevators and fans. The generating equipment consisted of two single-valve engines, directly connected to 220-volt three-phase 60-cycle generators, rated at 250 and 150 kva. respectively. The engines were operated non-condensing at 2 lb. back pressure to supply the exhaust for heating and the large quantities of hot water required by the entire institution.

As the institution increased in size, the old plant had grown from a single boiler and engine to seven boilers, operating at a pressure of 125 lb., and two generating units, but it grew in an undirected way.

New Power Plant Planned

By 1923 the institution had reached the point where the capacity of the boiler houses was taxed beyond the limit of safety, and in view of a building program of considerable magnitude, a power survey was ordered, as well as a careful investigation of all local conditions and estimates as to future loads. At this time the connected high-pressure live-steam load in pounds per hour was summarized as follows: For generating equipment, 13,800 lb.; for auxiliaries, 2,880 lb.; for heating minus exhaust steam, 18,480 lb.; for laundry, 6,450 lb.; for kitchen, 3,000 lb., and for water heating, 1,800 lb., making an aggregate of 46,410 lb. per hour and calling

for 15,470 sq.ft. of steam-making surface in the boilers. The contemplated building program called for an additional connected load by 1925 of 16,920 lb. of high-pressure steam per hour, making a total connected load of 63,330 lb., with an estimated peak load of 53,580 lb. By 1927 the total connected load was placed at 75,600 lb., calling for 25,200 sq.ft. of boiler surface, and the estimated peak load of 87,600 lb.

On the electrical side the old plant had a connected load of 517 kw., with an estimated peak of 309 kw. By 1927 it was estimated that the connected load would increase to 697 kw. and the peak load to 467 kw.

From these figures it is evident that the old plant was being used to its capacity without any reserve, and owing to antiquated equipment, improper draft conditions and lack of instruments, the operation was uneconomical. Another factor contributing to the poor results was that the water heaters were not large enough to supply adequately the needs of the institution, so that while exhaust steam was completely used in the winter for heating and hot water, a considerable portion of it was exhausted to atmosphere during the summer.

The installation of larger heaters in the new plant, however, relieved this condition. One heater of 13,000 gal. per hour capacity now supplies hot service water and another of 21,000 gal. capacity furnishes hot water for the laundry.

During the summer months the reduction in lighting load is partly counterbalanced by the demand of the refrigerating plant, which has a connected load of 115 hp. in motors. With the heating eliminated during this period a practical balance can be maintained between the supply and the demand for exhaust steam. This same condition exists during the heating months, so that throughout the entire year since the new plant was placed in operation, there has been little or no waste of exhaust steam.

As a result of the survey it was decided to scrap the old plant and build a new one. The only equipment that could be re-used to advantage was the 250-kva. generating set, a Venturi meter, a turbine-driven water pump of 300-gal. per min. capacity which furnished the domestic water supply, two vacuum pumps, an air compressor and a voltage regulator.

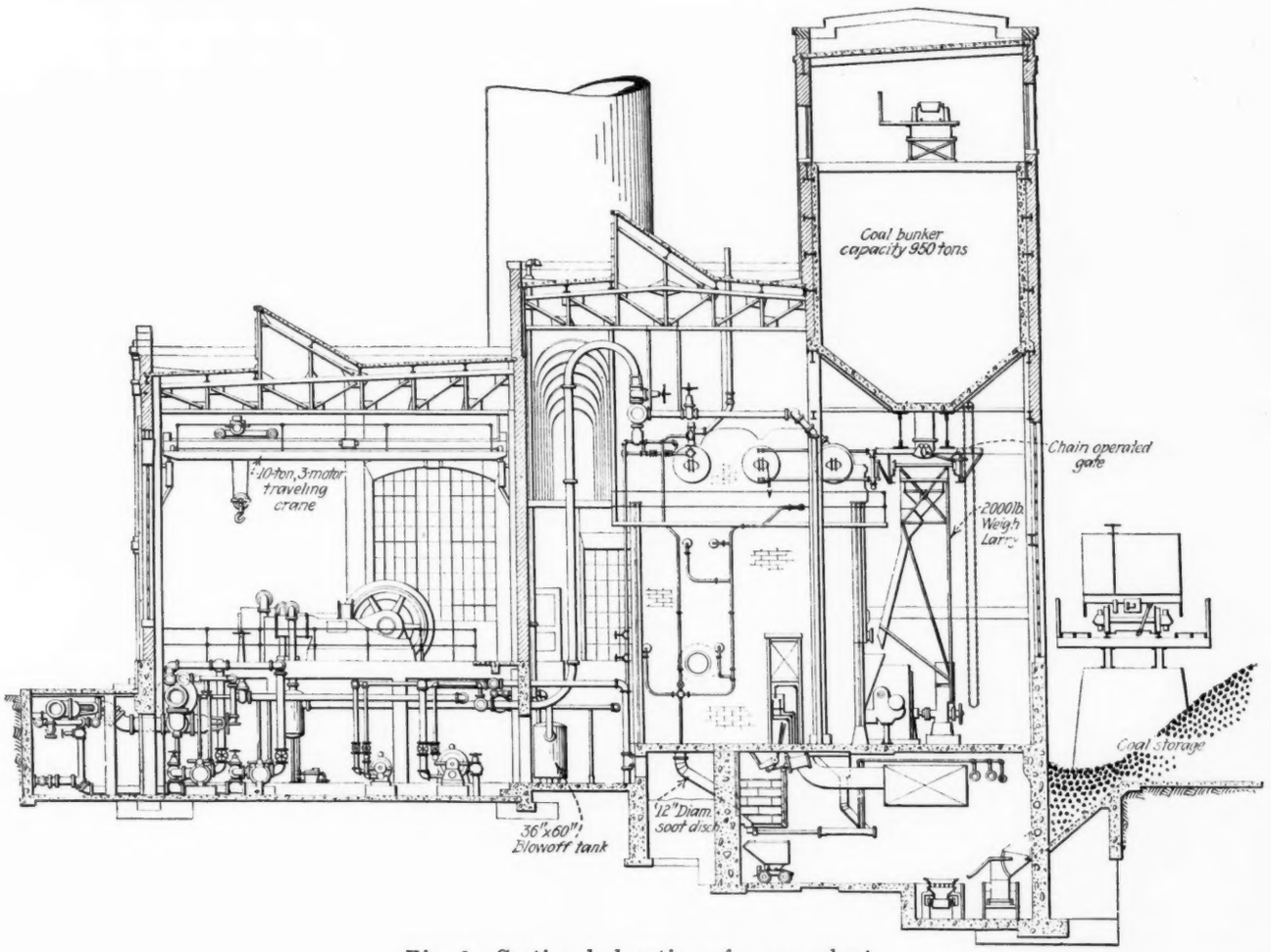


Fig. 2—Sectional elevation of power plant

The building of the new power house was complicated by the fact that steam had to be supplied to the institution 24 hours a day throughout the year, so that it was necessary that there be no interruption in service during the construction period. For this reason the plant was built in two sections, the first containing two new boilers equipped with underfeed stokers of the new interchangeable-tuyere type. Two of the old return-tubular boilers were taken out to make room for the new ones and a section of the new engine room large enough to house one unit was placed adjacent to the old engine room. During this period the load was carried by the remainder of the old plant.

Two weeks after the new equipment was placed in operation, the rest of the old plant was shut down and dismantled, and during the remainder of the construction period the two new boilers and the one engine were operated to carry the entire load, it being necessary for a period of about four weeks to rely on stand-by purchased electrical service, but at no time was the steam pressure lost. The second section of the new plant was ready for operation by Nov. 15, 1924, the total plant then consisting of five 5,006-sq.ft. boilers with space for a sixth, and three engine-driven generating units having an aggregate capacity of 850 kva., one of these being one of the old units which was thoroughly overhauled.

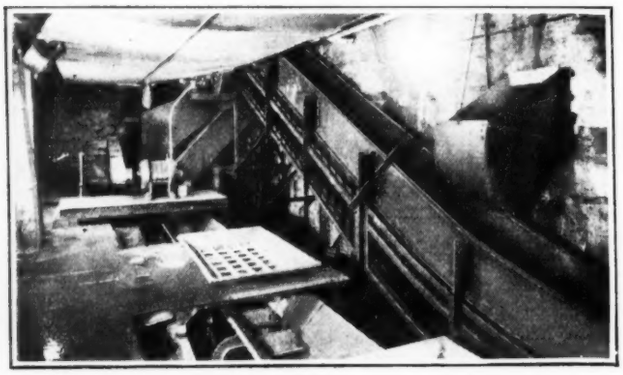


Fig. 3—Coal conveyors and crusher

During the last winter three of the boilers were operated at 125 to 150 per cent of rating to carry the load. In the summer one boiler will handle it and any one of the generating units will carry the electrical demand, although the winter load requires the use of two machines.

The boiler settings are made up solid of firebrick in an effort to avoid the constant maintenance costs on furnaces and settings experienced in the old plant. The boilers are set with the center of the mud drum 8 ft. above the floor to give ample furnace volume for the combustion of the West Virginia or Kentucky coal burned in the plant. This coal averages about 14,000 B.t.u. per pound with a volatile content ranging from 35 to 40 per cent. Feed-water regulators and soot blowers are provided. The stokers are driven by individual direct-current motors mounted above the rams to leave the floor more free of incumbrances. The starting rheostat is mounted on a control panel in front of the stoker, which also contains the draft gages giving the pressure in the windbox and the drafts over the fire and in the last pass. A CO_2 indicator is mounted on the front boiler column.

Automatically Controlled Air Supply

Although the stoker speed is controlled manually, the air supply to the furnace is automatically controlled by a regulator operated from the steam pressure, which throttles the steam supply to the fan engine. Two fan units are provided; each is capable of supplying three boilers operating at 200 per cent rating. Both discharge into a common duct with a single take-off to each stoker windbox equipped with a volume damper.

One radial brick stack rising 205 ft. above the grates, with a top inside diameter of 11 ft., serves the five boilers.

Coal is brought in on a trestle running along the building and elevated about 12 ft. above the boiler-room floor. Beneath this trestle are concrete pockets with gates opening into the basement of the plant. Through these gates the coal is discharged onto a pan conveyor and is carried to a motor-driven crusher at one end of the basement, this crusher being bypassed so that it need not be operated unless required. From the crusher or the bypass around it the coal enters a continuous bucket conveyor which delivers to an overhead bunker having a capacity of 1,000 tons. As indicated in the sectional elevation, Fig. 2, this bunker is made up of reinforced concrete and extends to a considerable height above the building proper. From the bunker the coal enters a traveling weigh larry, with the scale beam near the floor level, and is discharged into the stoker hoppers, which have been extended to hold 2,500 lb. each.

Ash-Disposal Facilities

Ashes are discharged from the boiler furnaces into tile-lined ash hoppers with steam-operated gates. The ashes drop vertically into dump cars and through a grizzley are transferred to the same continuous bucket conveyor that handles the coal, to be delivered to a 100-ton concrete ash bunker within the boiler house. From the bunker the ashes are chuted to trucks outside the building and either used on the premises or sold for road construction. Fig. 3 shows the grizzley over the continuous bucket conveyor, also the pan conveyor receiving the coal from storage, and in the background the coal crusher belted to a motor. The sectional elevation, Fig. 2, shows the ash hopper with a dump car set underneath, also a 12-in. soot discharge from the boiler to the ash hopper.

Water for the entire institution is purchased from Henry Ford's pumping station at Dearborn, and as the water is very hard it is softened on the premises by the cold lime-and-soda-ash process, not only for the boilers, but also for general use in the institution. As the steam used in the various buildings is conveyed through tunnels and the returns and drips are brought back through the same tunnels to the power house, only 5 per cent makeup is required, this being admitted from the mains to the heater under float control. It is supplied with steam from the main exhaust on which a pressure of 2 lb. is maintained.

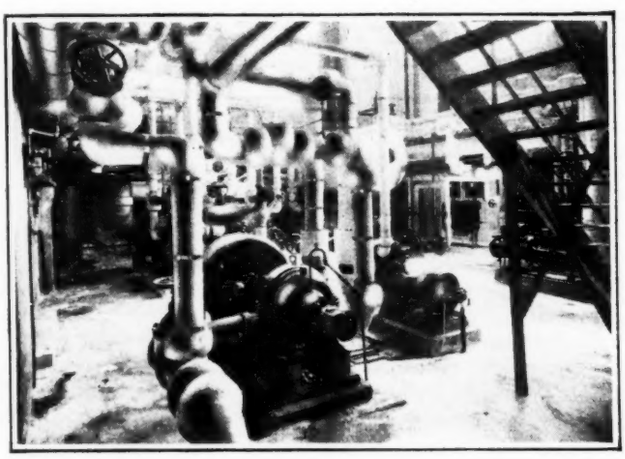


Fig. 4—General view in pumproom

Two steam-driven boiler-feed pumps are provided, each one having sufficient capacity to care for the entire plant. They are supplemented by an injector on each boiler. A 10-kw. direct-current turbine-driven generating set is used to provide excitation when starting up the plant and as an additional stand-by for the motor-generator sets installed on the main floor of the engine room. One of these sets supplies direct current for operating the stoker motors, the fire alarm system

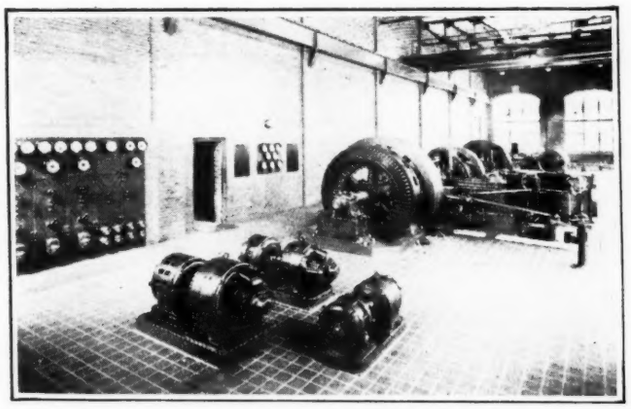


Fig. 5—Generating room of Eloise station

and the X-ray laboratory. The second set supplies direct current for excitation purposes, and the third motor-generator is used as a stand-by for either of the services mentioned. Much of this equipment may be seen in the photograph of the engine room, Fig. 5, with the switchboard at the left and in the background the railing surrounding the open pumproom.

Piping and valves are standard for the pressure used. The usual stop-and-check and gate valves are inserted in the boiler leads. The main steam header is sectionalized, and leads at either end to the engine header and to the auxiliary header circulating the pumproom form a continuous loop so that the supply may come from either direction to the various units served. The header is valved into three sections, any one of which can be shut off for repairs.

Cost of the New Plant

Records are available to show that the entire cost of the building and equipment, including the tearing down of the old plant and the removal of rubbish from the premises, approximated $570,000. Owing to the fact that no complete records were kept in the old plant it is impossible to estimate the saving effected, but the reduced coal consumption, notwithstanding the increased load on the plant, indicates a considerable gain. As an indication, for the month of June, 1925, the coal consumption was 540 tons, as compared with 764 tons in June of 1923, when the old plant was in operation. During the interval the load had been increased by the addition of two large hospital buildings.

The plant was designed and construction supervised by The E. R. Little Company, Inc., of Detroit, Mich., serving as consulting engineers for the Board. Maul & Lentz, architects, of the same city, designed the building.

PRINCIPAL MECHANICAL EQUIPMENT IN ELOISE POWER PLANT

BOILERS

Manufacturer	Babcock & Wilcox Co.
Type	Stirling water-tube
Number installed	5
Heating surface each, sq.ft.	5,006
Heating surface per sq.ft. of grate area	62
Working pressure, lb. gage	140
Coal burned	Bituminous, 14,000 b.t.u.

STOKERS

Manufacturer	American Engineering Co.
Type	Taylor five-retort, interchangeable-tuyere, underfeed.
Grate area, sq. ft.	80.6
Drive	D. C. motor

FORCED-DRAFT FANS

Manufacturer	Clarage Fan Co.
Number installed	2
Capacity, cu.ft. per min. against static pressure 5 in. water	35,000
Drive	Vertical single-cylinder steam engine
Automatic control	Keilholtz regulator

CHIMNEY

Builder	Alphons Custodis Chimney Co.
Type	Hollow radial block
Diameter at top, inside, ft	11
Height above grate, ft	205

COAL AND ASH HANDLING EQUIPMENT

Manufacturer	Stephens-Adamson Mfg. Co.
Conveyors	Pan and bucket
Weighing	Traveling weigh larry
Crusher	Single roll, 60 tons per hour

FEED-WATER HEATER

Manufacturer	H. S. B. W. Cochrane Corp.
Number installed	1
Type	Horizontal, open
Capacity, lb. per hour	150,000
Feed-water measurement	Venturi recording meter
Feed-water control, Copes	Northern Equipment Co.

BOILER-FEED PUMPS

Manufacturer	Union Steam Pump Co.
Number	2
Type	Burnham outside center packed
Capacity, gal. per min.	165
Drive	Steam
Automatic control	Copes regulator

GENERATING UNITS

Engines	Erie Ball Engine Co.
Number installed	3
Type	Two 4-valve, one single-valve
Generators	Westinghouse Elec. & Mfg. Co.
Capacity	One 350 kva., two 250 kva.
Type	3-ph., 60-cycle, 220-v.
Remote control	Cleveland Electric Co.
Switchboard	Cleveland Electric Co.

DIRECT-CURRENT SUPPLY

Motor-generator sets, three	Allis-Chalmers Mfg. Co.
Exciter, turbine driven	DeLaval Steam Turbine Co.
Voltage regulator	Westinghouse Elec. & Mfg. Co.
Automatic starters	Sundh Electric Co.

MISCELLANEOUS EQUIPMENT

Cold-water service pump, one, turbine driven	Kerr Turbine Co.
Hot-water service pumps, three, motor driven	Buffalo Steam Pump Co.
Vacuum pumps, two	Union Steam Pump Co.
Sump pump	Kerr Machinery Co.
Hot-water storage tank	Frederick H. Mason Co.
Water heaters, two	Ross Heater & Mfg. Co.
Air compressor, one, vertical	Westinghouse Traction Brake Co.
Traveling crane, eng. rm., 10-ton	Cecil R. Lambert Co.
Soot blowers, 6 elements per boiler	Diamond Power Specialty Corp.
Ash hopper and gates	Baker-Dunbar Co.
Soot gates and ash cars	R. H. Beaumont Co.
Smoke breeching	Acme Boiler Works
Galleries and runways	Whitehead & Kales
Pipe covering	Johns-Manville, Inc.
Power wiring	Kuehne Electric Co.
Non-return valves	Illinois Engineering Co.
Gate valves	Crane Co.
Blowoff valves	Yarnall-Waring Co.
Reducing valves	Illinois Engineering Co.
Pressure recording gages	Crosby Steam Gauge & Valve Co.
CO_2 indicators and recorders	Uehling Instrument Co.
Draft gages	Lewis M. Ellison

Three-Speed Traction Elevator Direct-Current Controller

BY CHARLES A. ARMSTRONG

Explains in Detail the Circuits and Operation of a Three-Speed Controller for Use on Traction Elevators

ARRANGEMENTS of contactors and circuits involved in electric-elevator controllers are almost unlimited, and the equipment of the various manufactures may be radically different for doing the same service, so much so that in general each type offers an interesting study. The elevator controller described in this article is a Payne Elevator Controller Co.'s type No. 13-E three-speed, as used on the single-wrap traction elevator machines in the new Empire Hotel, New York City.

The type of elevator machines is similar to that in Fig. 1, with a hemp-fiber-packed traction sheave as built by the Neenan Elevator Corp. Instead of the traction sheave having a steel rim with V-grooves to grip the cables, the rim is built up of short pieces of hemp fiber set on end and held between heavy flanges as indicated in Fig. 2. After the rim has been assembled, the sheave is placed in a machine and semicircular grooves are rolled into its surface for the cables. The friction between the hemp fiber and the steel cables is sufficient to prevent slipping with half-wrap roping, and the wear on the cables is practically negligible.

A photograph of the front of the controller is shown in Fig. 3 and a wiring diagram in Fig. 4. The identification letters on the two figures correspond so that one can be easily compared with the other. The following explanation of the various circuits will show the function of each contactor:

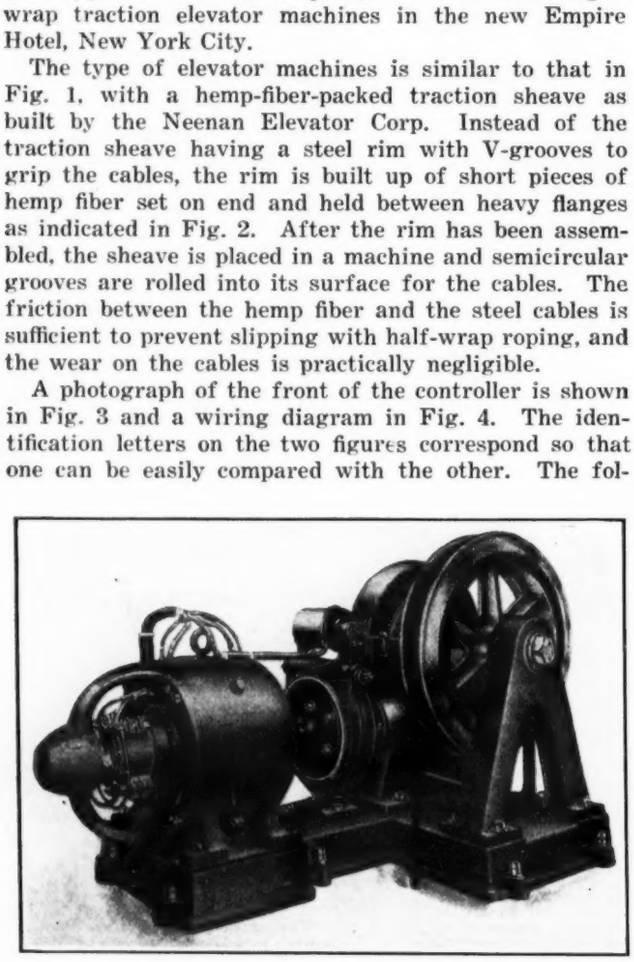


Fig. 1—Single-wrap traction elevator machine with hemp-fiber-packed traction sheave

In a good many types of controllers the safety circuits and the potential switch are separate from the direction switch circuits. On the controller in question these two circuits are combined in one. This circuit is from the + side of the line to No. 1 terminal on the control board, through fuse F_c to A', through the governor switch, the overtravel hatchway limit switches, the emergency switch in the car and back to terminal B' on the controller. From B' the circuit continues through coil D_1 on one of the potential switches, through resistance R_{12} and coil D, on the combination potential and dynamic-brake switch, to between coils C_2 and C_3 of the up and down direction switches. If the car switch is in the down position, the circuit will be through coils C_1 and C_2, and if in the up position the circuit is through coils C_3 and C_4.

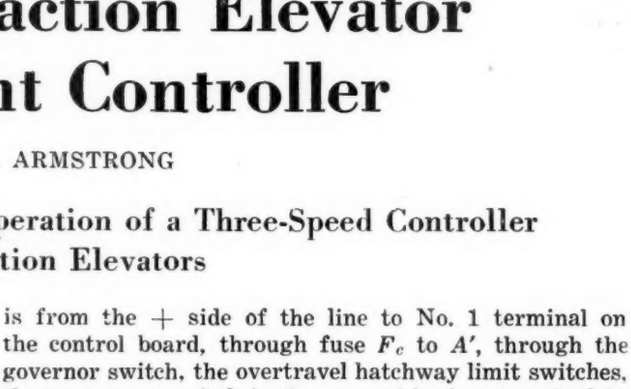


Fig. 2—Shows construction of hemp-fiber-packed traction sheave

Assume the car switch to be in the down position, then the circuit is through coils C_2 and C_4, to E' at the top of the controller and to limit switch S_l and to contact E'' on the car switch. With the car switch thrown to the down position, contacts C'', D'' and E'' are connected to G'', so that from E'' the circuit is to G'' back to F' on the control board to fuse F_l, the top contact of potential switch D_1 and to the — side of the line. This energizes coils D_1 and D on the potential switches and coils C_2 and C_4 on the direction switches, and all four switches close.

With potential switch D open, its bottom contact is closed and completes the dynamic-braking circuit through the armature to assist in stopping the elevator. When the top contact of this switch is closed, the bottom contact is open, this interrupting the dynamic-brake circuit.

With the two potential switches and two down-direction switches closed, a number of circuits are completed, one of which is the brake. This circuit is

from terminal T_1 at the top of potential switch D through the brake coil and back to terminal T_2 on potential switch D_1. This connects the brake coil directly across the line and causes it to lift the brake shoes and release the elevator.

The Armature Circuit

Another circuit completed by the closing of the potential and direction switches is that of the armature. This circuit is from the + side of the line through the top contact of potential switch D and to the bottom end of contactor A_1. From contactor A_1 the circuit is through the series field, all of the starting resistance to direction switch C_2, through this switch to the armature and back to the bottom of direction switch C_1. From here the circuit continues through switch C_1, coil I on the speed-stabilizing contactor, through potential switch D_1 and to the — side of the line. This compietes the armature circuit through all the starting resistance and the motor starts, unless overloaded.

The starting resistance is cut out of the armature circuit by contactors J and A_1 to A_4. Contactor J is of the time-limit type and is adjusted to close in a given time irrespective of the load on the motor. Contactors A_1 to A_4 are of the counter-electromotive force type and are closed by the voltage across the armature terminals. If all the contactors were of the counter-electromotive force type and the motor was heavily loaded, it is possible that none of the contactors would close. By making one of the contactors of the time-limit type, a section of the resistance will be cut out in a definite time whatever the load may be on the motor, and this insures that the voltage across the armature terminals will reach a value to insure contactors A_1 to A_4 closing. Whether contactor J or A_1 will close first will depend upon the load on the motor. If the load is light, A_1 will probably close before J, and if the load is heavy in the up direction J should close before A_1 contactor.

Operation of Accelerating Switches

The circuit of coil J is from T at the top of potential switch D through coil J, resistance R_1 to the top of contactor C_1 and to the negative side of the line. The time required for this switch to close is adjusted by a small dashpot at P in Fig. 3. When contactor J closes, it cuts out section R'_1 of the starting resistance.

The four coils of the switches A_1 to A_4 are in series and are connected across the armature terminals, but are under the control of contactor F. The circuit for coil F is from T on the potential switch D, through coil F, resistance R_3 to D'' on the car switch and returns to the negative side of the line, assuming the car switch in the full down position. This energizes coil F and causes it to close its top contact and open its bottom contact, an operation that occurs as soon as potential switch D closes and the car switch is on D'', the second-speed point.

With contactor F closed a circuit is completed for coils A_1 to A_4 from the bottom of contactor C_1, at A_4, through coils A_1 to A_4, through the top contact of F and to the bottom of contactor C_2 at A_1. The bottom of contactor C_2 connects to the left-hand armature terminal, and the bottom of contactor C_1 connects to the right-hand terminal of the armature, therefore coils A_1 to A_4 are connected directly across the armature terminals.

Contactors A_1 to A_4 are adjusted by screws S, Fig. 3, so that the armature of A_1 is the closest to its magnet core and A_4 is the farthest away from its magnet core. When the motor reaches a speed where the counter-electromotive force is high enough, contactor A_1 closes and cuts out R'_2 section of the starting resistance. This causes the motor to increase in speed, the counter-electromotive force increasing and contactor A_2 closes, cutting out section R'_3 of the starting resistance. A little later A_3 closes and cuts out section R'_4 of the starting resistance, followed by the closing of A_4. When A_4 closes, it not only cuts out R'_5

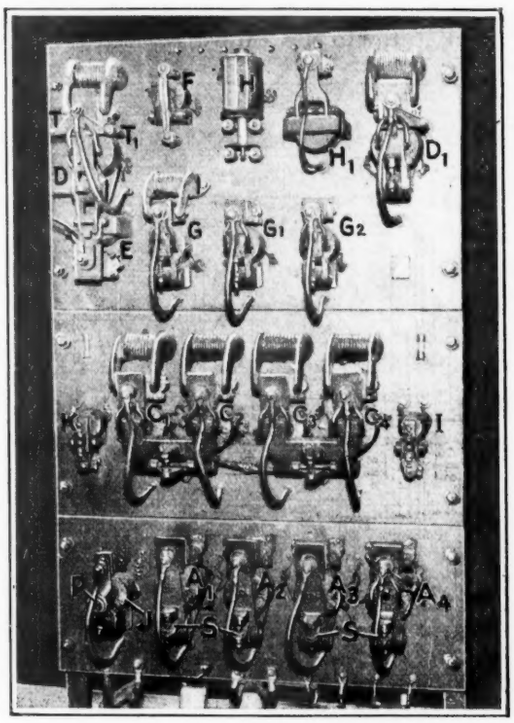


Fig. 3—Three-speed controller for traction elevators

the last section of the starting resistance, but also the series-field winding, if the winding is used on the motor. Instead of the armature circuit now going from the bottom of contactor A_4 through the series-field winding, the circuit is up through contactor A_4 to U between the direction switches. From here the armature circuit is as previously explained.

Shunt-Field Circuit Energized Continuously

The shunt-field circuit remains energized at all times. This circuit is from the top main contact of potential switch D, which is connected directly to the + side of the line, through resistance R_2 to terminal X on the potential switch, down to terminal 4 at the bottom of the controller, to H_2, through the shunt-field winding to I'. From I', there are two circuits, one to the top of contactor H_1, which is held normally closed by springs, then through the two bottom contacts on relay H, through a section of resistance R_4 to contact H_1 of relay H, to the top contact of potential switch D_1 and to the — side of the line.

From tracing through the shunt-field it is seen that the shunt-field coils are excited all the time. With the closing of potential switch D resistance R_2, which is in

series with the shunt-field coils when D is open, is short-circuited, and the path of the current is directly through contactor D to terminal X without going through resistance R_2. This allows the shunt-field to build up to full value during the first part of the accelerating period and gives the motor a strong starting torque. Under this condition and with the closing of contact A_1 to A_4 the motor comes up to second speed.

When contactor A_4 closes, it completes a circuit for coil H from contact W, through resistance R_6, coil H to terminal C' at the top of the controller, to down contact C'' on the car switch and to the — side of the line as previously explained. This energizes coil H and causes it to lift its core and close contacts H_f. motor becomes a generator and pump back in the line, thus acting as a brake to prevent the car from overspeeding. When the current though coil I reaches a low value, it releases its armature and allows contact I_s to close. This provides a circuit for the shunt-field coils from I' through contacts I_s to a point in R_4 resistance, then through R_2 resistance. From this it is seen that the closing of contact I_s cuts part of R_4 resistance out of the shunt-field circuit, which will result in increasing the field strength and tend to slow the motor down and prevent it from overspeeding. In other words, the function of relay I is to assist in stabilizing the speed of the motor.

In slowing the elevator down, either by the car

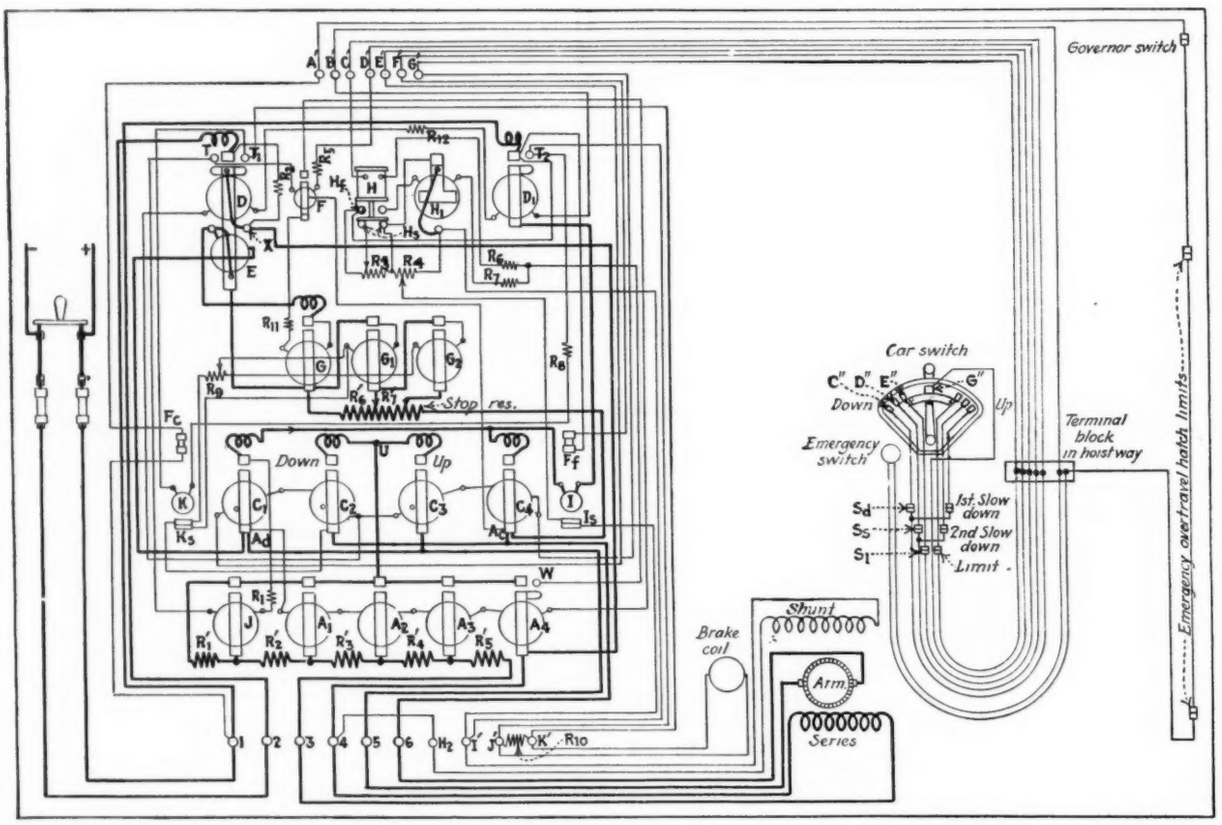


Fig. 4—Wiring diagram for the controller Fig. 3

In so doing, relay H inserts resistance R_2 in the shunt-field circuit and it also completes the circuit for H_1 coil.

The circuit for coil H_1 is also from contact W on magnet switch A_4 through resistance R_2, coil H_1, top contacts on H, to the top contact of potential switch D_1 and to the — side of the line. This energizes coil H_1 and causes it to open its contact, and now, instead of the shunt-field current passing through the top contact of H_1, it must flow through resistance R_1 in series with R_2, which brings the motor up to full speed.

In tracing out the armature circuit, it was found to pass through the coil of stabilizing relay I. The energizing of this coil from the armature circuit causes it to open its contact I_s just as soon as the current builds up in the armature and to hold these contacts open as long as the current remains above a certain value in the armature. Suppose with a heavy load in the car going down, the motor increases in speed to where the current reaches nearly zero, or the switch or by the terminal limit switches, the first operation is the opening of coil H circuit, by moving the car switch back of point C'' or by the opening of the first slow-down contact S_d. This would cause coil H to release its core, which opens contacts H_f and closes contacts H_s, the latter short-circuiting resistance R_2 out of the shunt-field circuit.

Opening contacts H_f also opens the circuit through coil H_1, which releases its contactor and short-circuits resistance R_1 out of the shunt-field coil circuits. This operation brings the shunt-field to full strength and the motor slows down to a speed corresponding to this condition.

The next step in slowing down is moving the car switch off contact D'', or the second slow-down contact S_s opens as the car approaches the lowest landing. This operation opens the circuit through coil F and causes it to release its contactor, which breaks the circuit at the top and closes it at the bottom. Opening

the top contact of F interrupts the circuit through coils A_1 to A_4, causing their contactors to open, and sections of the starting resistance R_2 to R_4 and the series-field winding are put back into circuit with the armature, thus further reducing the speed of the motor.

Resistance Connected Across the Armature During Stopping Period

When magnet F closes its bottom contact, a circuit is provided for coil G, from A_c at the bottom of C_4 to F, through resistance R_{11}, coil G, coil E on the lower end of potential switch D, through direction switch C_1 and to the — side of the line. Energizing coil G closes its contact and connects the stop resistance R'_6 and R'_7 across the armature from A_c through the stop resistance, contact G, coil E to A_d, through direction switch C_1 and to the — side of the line. This shunts part of the current flowing through the starting resistance around the armature and gives a very slow speed for stopping.

Connecting the stop resistance across the armature applies a voltage across coils G_1 and G_2, since these coils are connected across the stop resistance. The circuit for coil G_1 is from the bottom end of direction switch C_2, to which is also connected the right-hand end of the stop resistance, to contact K_8 on relay K. If the contact were closed, the circuit for coil G_1 would be directly to the coil and to the left-hand end of the stop resistance. Therefore, whatever voltage exists across the stop resistance is also applied to coil G_1 and might cause it to close and cut out part of this resistance, which with this controller should not be done with power applied to the motor. It is to prevent this that relay K is used.

Coil K is connected from contact T_1 on potential switch D to T_2 on potential switch D_1, which connects this coil across the line through resistance R_8 as soon as the potential switches close. This causes relay K to open contacts K_8 and cuts resistance R_9 in series with coils G_1 and G_2 and prevents them from closing their contacts.

Third Operation When Stopping

The third operation in stopping the elevator is for the operator to bring the car switch to the off position or the opening of the limit switch S_l. This interrupts the circuit to potential switches D and D_1 and the direction switches C_1 and C_2 and causes them to open. The opening of the potential switches also interrupts the circuit to relay K which allows its contacts K_8 to close and short-circuit resistance R_9 out of circuit with coil G_1.

The opening of the potential switch also interrupts the circuit through coil G and allows its contactor to open. When the potential switch D opened, its bottom contact closed the circuit for the armature through the stopping resistance. This circuit is from A_c through the stopping resistance to the bottom contact of potential switch D through coil E on this switch to A_d and through the armature back to A_c. This causes the motor to act as a brake and helps to bring the car to rest. Coil E, being in the armature circuit, is energized and exerts a pull on the contactor to prevent any rebound after this contact once closes.

One side of coil G_1 is connected through contact K_8 to A_c and the other to the top contact of G_1, and around to A_d. This connects coil G_1 across the armature. If a medium load is being stopped, the voltage of the armature will be high enough to cause G_1 to close its contactor; in so doing it short-circuits out section R'_6 of the stopping resistance. This reduces the resistance in the armature circuit and tends to hold the current constant as the machine slows down, thus giving additional assistance to the mechanical brake in stopping the car.

With a heavy load on the car the voltage generated by the armature would be sufficient to cause coil G_2 to close its contact and short-circuit section R'_7 of the stopping resistance out of the armature circuit. This would allow the armature to develop a high braking effect at very low speed, so that even though the mechanical brake failed to hold the load, the car would move only at a very slow speed. The circuit for coil G_2 is from the left-hand terminal of G_1 through part of resistance R_9, coil G_2 and top contact of G_2 to the armature, as was the circuit for coil G_1. When the motor comes to rest, contactors G_1 and G_2 open and the controller is ready for the next starting operation.

Application of the Brake

Resistance R_{10} is connected across the brake coil so that when the latter circuit is opened by the opening of the potential switches, D and D_1, the brake will not be applied suddenly. Owing to the induction of the brake coil a current is maintained for a short period through this coil and resistance R_{10} which tends to prevent the brake shoes slamming on the brake wheel and giving an unpleasant stop.

For the up motion the functions of the controller are the same as for the down motion, except that the car switch is placed in the up position and up direction contactors C_3 and C_4 close instead of down contactors C_1 and C_2. The direction contactors are mechanically interlocked so that when one is closed the other must be open, thus avoiding the danger of a short-circuit if both were closed at the same time. The slow-downs and limit switches with this controller are mounted on top of the car and are opened by a cam in the hoistway at the terminal landings. If for any reason these switches did not stop the car and it went by the terminal landing, the emergency overtravel switch would be opened and interrupt the control-circuit. In such a case the elevator cannot be started from the car switch until the car is moved off the emergency limit switch. If the car should for any reason overspeed, the governor will set the safeties on the car and the governor switch will be opened and interrupt the circuit to the potential and direction switches, thus stopping the motor.

The average engineer condemns oil upon finding carbon deposits in the cylinder of an engine using superheated steam. Such a deposit often does not constitute a good and sufficient reason for the rejection of the oil, for most investigations have shown that it is not the decomposition of the oil under high temperature that causes carbon deposits, but rather that it is due to the excessive amounts of oil fed to the cylinder. Excessive oil will be indicated by an accumulation at the ends of the valve travel or in the counterbore of the cylinder. In many cases of reported carbonization of oil investigation has shown that these deposits are largely composed of dirt carried over in the steam main from the boilers.

Atmospheric Relief Valves Eliminated at Toronto Station

Vacuum Failure, Acting Through Mercury Column, Tripper, Weight, Levers and Pilot Valve, Closes Main Trip Throttle of Turbine—Rupturing Diaphragm Provided as Additional Safeguard

THE new Toronto station of the Ohio River Edison Co., the general features of which were briefly outlined in the Oct. 21, 1924, issue, has a number of points of unusual interest. One is the heat-balance system, which will be the subject of a special article in the near future.

The present article is particularly concerned with certain ingenious devices that have made possible the elimination of the customary atmospheric-relief valves and piping, with a considerable saving in first cost, accompanied by a marked improvement in vacuum over that ordinarily expected under conditions similar to those existing at Toronto.

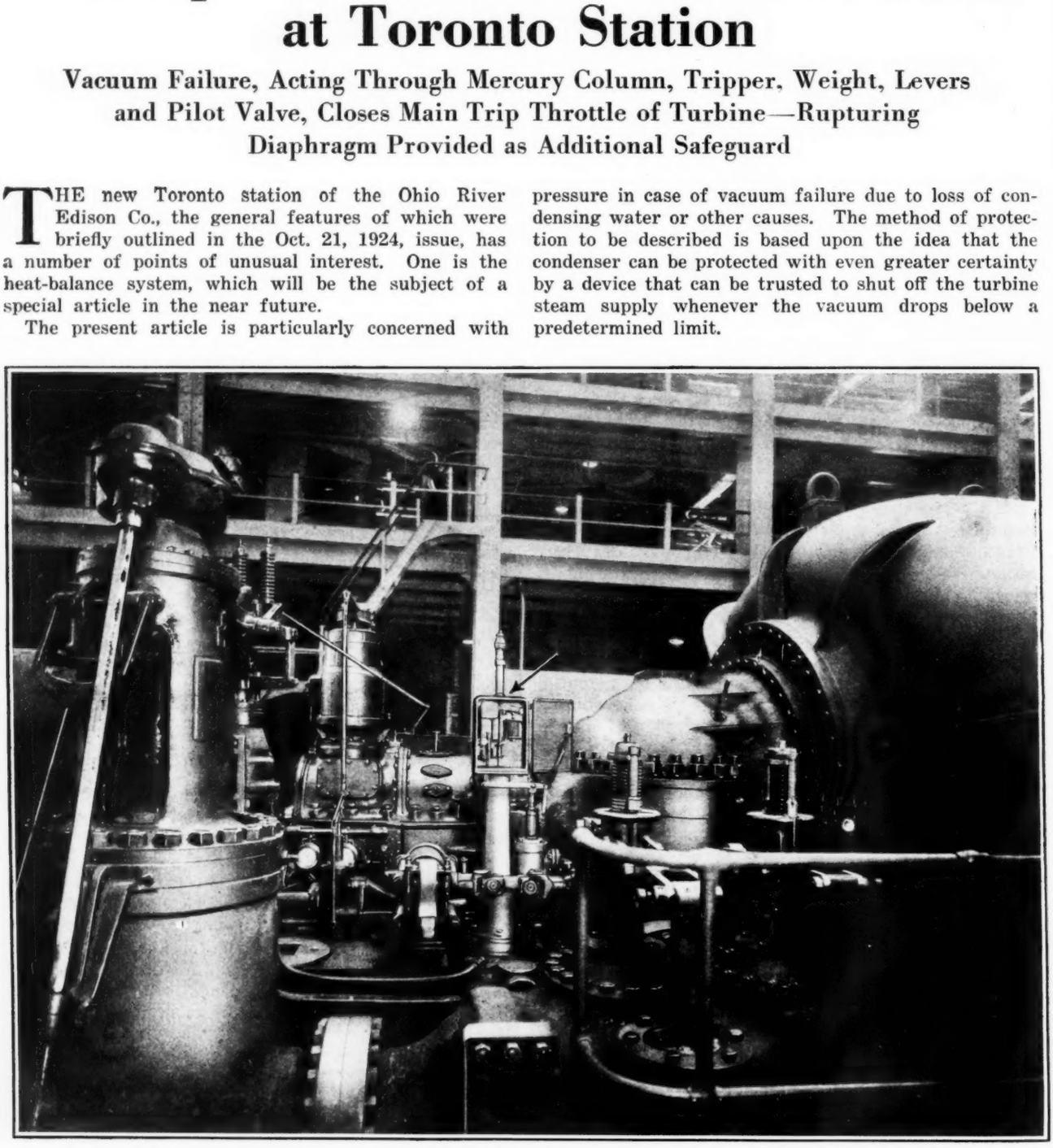


Fig. 1—Installation of vacuum tripper on 33,000-kw. turbine in the Toronto Station

The purpose of the atmospheric-relief valve is to protect the condenser from an accumulation of steam pressure in case of vacuum failure due to loss of condensing water or other causes. The method of protection to be described is based upon the idea that the condenser can be protected with even greater certainty by a device that can be trusted to shut off the turbine steam supply whenever the vacuum drops below a predetermined limit.

The heart of the apparatus is shown in Fig. 2. It consists essentially of a mercury column supported by the vacuum, failure of vacuum causing the mercury to pass from the column to a float chamber, where it operates the float. This in turn, through a simple mechanism, operates the pilot valve or other device controlling the trip throttle.

The drawing shows the apparatus set for normal

operation. Column *A* is connected directly to the condenser by an oversize pipe with no intervening valve. The mercury level in it must therefore stand above that in the float chamber *B* by an amount corresponding to the vacuum, generally around 29 in. If the vacuum falls for any reason, some of the mercury passes from *A* to *B*. After it has risen a certain amount in *B*, the mercury starts to lift the float, and with it the double collared sleeve *C*, clamped to the rod *D* by spotted setscrews. The upper collar raises the latch *E*, which in turn lifts the lever *F*. This allows the unbalanced weight *G* to fall, pushing down the rod *H*, which works the lever arm of the pilot valve controlling the throttle latch, thus shutting down the turbine.

It is believed that the reliability of this arrangement is at least equal to that of the emergency overspeed trip. The mercury column and float chamber are so proportioned that the actuating force on the float is more than ten times that normally required to trip the valve. A bad air leak in the line connecting column *A* to the condenser would merely hasten the operation of the device.

With the turbine at rest and no vacuum on the condenser, the level of mercury is the same in *A* and *B*. This level is such that the lower collar of the sleeve *C* lies just below the latch *E*. If the vacuum builds up properly, after circulating pumps and air pumps are started, the float falls, slipping the upper collar down past the latch to the running position shown in the sketch. If, on the other hand, an attempt should be made to start the turbine without circulating water, the pressure would build up above atmospheric, bringing the lower collar into contact with the latch. At a pressure around 2½ lb. gage the lower collar would trip the latch, shutting down the turbine exactly as in case of failure of vacuum in normal operation.

As previously suggested, the spool may be located by setscrews to trip the throttle at any desired vacuum between 5 in. and 25 in. In the present operation at Toronto it is set to trip at 17 in., which allows an ample margin of safety.

As installed at the Toronto plant the device was also conveniently made to perform some additional electrical functions. A solenoid, not shown in the drawing, was added to trip the lever *E* whenever the generator circuit breaker opens, insuring the prompt shutting down of the turbine at such times. This, however, operates only when trouble occurs in the generator or breakers. In order to prevent motoring of the generator and turbine when the throttle is tripped from loss of vacuum, a switch is operated by the vacuum tripper which opens the main generator circuit breaker. It would be a simple matter to arange the vacuum tripper to close the governor valves, as well as the trip throttle.

Reduction in the first cost of the station was not the only reason for installing this device. It was felt that an atmospheric relief valve, even though water-sealed, always leaks air through swirls of water at points of poor contact. It was also feared that scale might build up around the seating surfaces, causing a tendency to stick, aggravated by the infrequent operation or testing of the valves.

Although the chance of the apparatus failing to operate in an emergency is felt to be practically nil, a further safeguard against condenser failure is provided

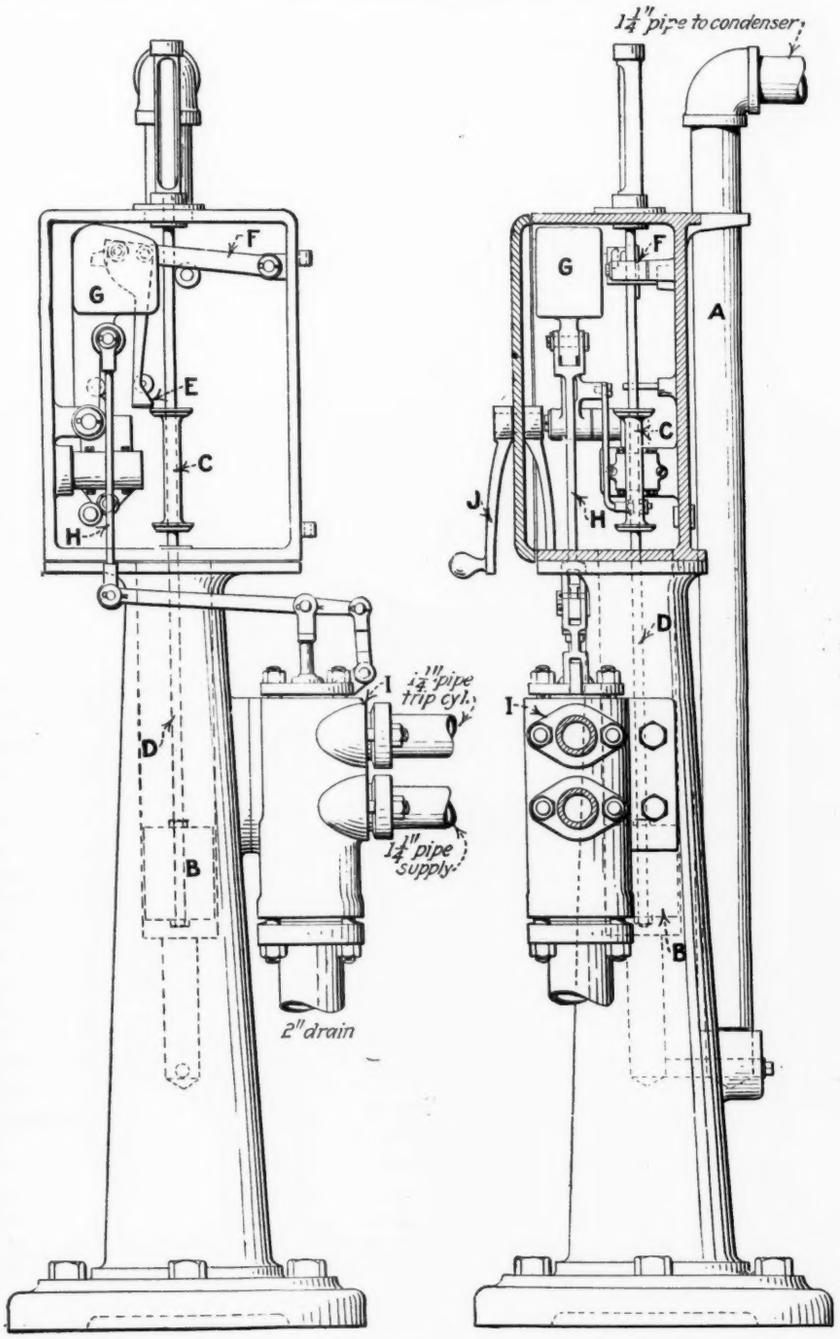


Fig. 2—When vacuum fails, mercury leaving A raises float B, tripping lever E, which releases weight G to operate the pilot valve

in the form of a lead-alloy blowout sheet, applied outside of a grid on the condenser to protect it from inward breakage by the vacuum. The details of this arrangement are shown in Fig. 3. It will be noticed that the lead composition sheet is backed up by a ¼-in. thick brass plate to insure that the lead, in case of over-

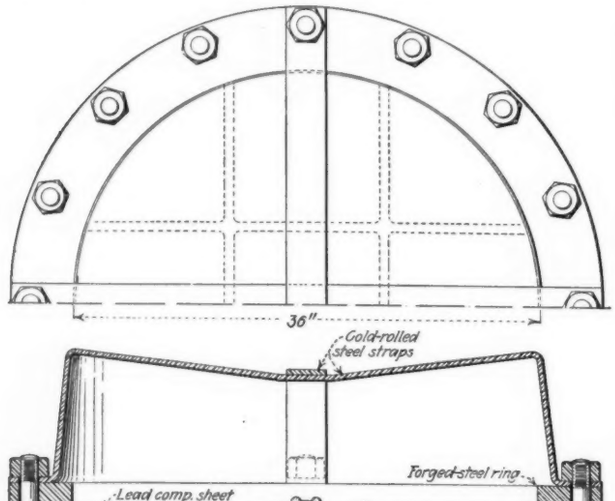


Fig. 3—Rupturing diaphragm designed to blow out if tripper should fail to handle over-pressure

pressure, will shear around the circumference of the disk and not merely bulge out. With a sheet thickness of about ½ in. and a grid diameter of 36 in., the disk will shear under a gage pressure of about 10 lb. per sq.in. The chance of such a rupture ever occurring is believed to be remote.

Lantern Glands Keep Out Air

While cutting down air leaks by elimination of the atmospheric relief valve, it was thought well to carry the process a little further. There are perhaps fifteen gate valves on various lines connected with the condenser body. These include valves in lines to air pumps, hotwell pumps, drip returns from meters, etc. All these valves have been provided with water-sealed lantern glands around the stems, practically eliminating air leaks at these points. The success obtained may be judged from the fact that a vacuum of 29.3 to 29.4 in. (reduced to 30-in. barometer) has been maintained steadily since the 33,000-kw. unit was started. The second unit is now operating with results that are equally good.

The saving in first cost with this method of condenser protection, as compared with atmospheric relief valves and piping, is about $14,000 for a single 33,000-kw. unit.

The apparatus was invented and patented by R. J. S. Pigott, who was with Stevens & Wood, Inc., Engineers, designers of the Toronto station, at the time of installation, and is now consulting mechanical engineer for the Public Service Production Company (Newark, N. J.).

The apparatus is a development of a simpler device that Mr. Pigott installed at the Seventy-fourth Street Station of the Interborough Rapid Transit Co., New York City, some years ago, on the first 30,000-kw. cross-compound turbines.

Gradual Failure of Ancient Engine Shaft

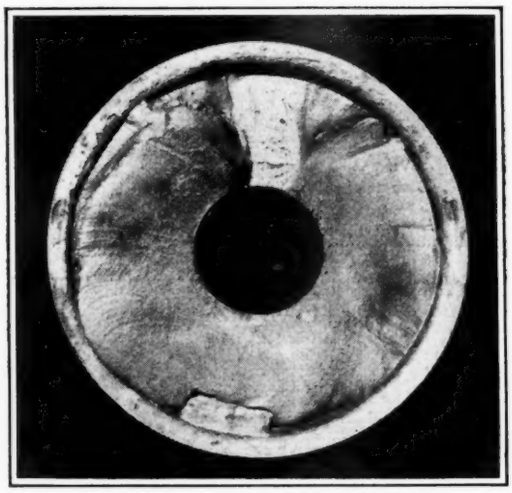
By W. F. Quinn*

After 34 years of service a 90-kw. engine-generator set was removed from the Boston Public Library on account of a progressive shaft failure, coupled with the fact that the march of progress demanded higher efficiency. When originally installed in 1891, it was a masterpiece from a mechanical viewpoint. Designed by E. D. Leavitt, a genius of his time, it survived him by about four years. The engine was built to order by I. P. Morris, Camden, N. J., and the 110-volt direct-current generator by Siemens-Halske, a German concern.

The shaft was known to have run out of true for a long period. Immediately after taking charge, I noticed this to be serious. The armature and field began rubbing, making an examination imperative. A large crack was located, extending across 92 per cent of the shaft area, as shown in the figure. Only the rectangular area at the top then remained to unite the shaft. The end of one of three keys appears at the bottom.

The shaft carried for its burden a wheel weighing twelve tons and a generator of two tons, revolving 125 revolutions per minute for an average of fifteen hours a day.

The set was not accurately aligned, so that wearing may have been the cause of the defect rather than an abnormal tendency toward crystallization. The crack occurred in a fillet between the larger engine shaft diameter and the smaller diameter on which the arma-



Bright area above represents about 8 per cent of original 8-in. shaft area remaining

ture spider was pressed. The surfaces of the crack were rubbed bright, indicating considerable mechanical friction over a long period.

A Nordberg high-efficiency engine is now being erected to replace this old unit.

A pumping plant with a capacity equal to the municipal water-works of a city of nearly one-half million population will be part of the equipment of the steamship "Malolo," which, when completed, will be the largest and fastest high-powered passenger steamer ever built in the United States. In exact figures the "Malolo's" pumps will handle 38,615 gal. per min.

*Superintendent Boston Public Library

Supersaturated Steam in Turbine Nozzles

ICE, water and steam are all composed of the same kind of particles or molecules. If we think of these as steel balls such as are used in a ball bearing, and each one magnetized so they all would tend to stick together and form a mass, the condition of water is in a way represented. Water actually, however, is in a somewhat different condition. The molecules or balls are in a state of movement or vibration, and not in close contact. Some are bumped around in such a way as to be thrown entirely out of the liquid body. If cold water and dry atmospheric air are present in a boiler, some of the wanderers will be caught in the air, giving it a certain percentage of water vapor. Others, however, will fall back through the air when saturated, again entering the water body.

Suppose no air were present and the space over the water momentarily were a perfect vacuum, reading 30 in. on a vacuum gage. The projected balls would immediately fill the space forming a vapor or steam.

Pressure against each square inch of the containing vessel would result from the constant hitting of these moving balls. It would equal that for saturated steam shown in steam tables for the temperature of the water. If the latter is 60 deg. F., the steam or vapor pressure would be approximately 0.53 in. of mercury, thus reducing the vacuum gage reading to 29.47 inches.

Temperature affects the tendency of the balls to fly apart. The hotter the vapor the greater the molecular speed and the higher the impact or pressure per square inch. Steam at any known pressure can be turned into a plastic liquid or a rigid solid (ice) by chilling it sufficiently and keeping the pressure constant. The moving forces acting on the balls in the last condition would be so reduced as to prevent any one from roaming in an independent path.

On the other hand, pressure controls the force holding the balls together at a given temperature. If pressure is gradually raised on steam at 300 deg. F., it may be turned into water.

Steam formed as first described is dry or saturated. If the pressure is held constant but the temperature raised (which would require an increase in volume for the steam) it would be superheated.

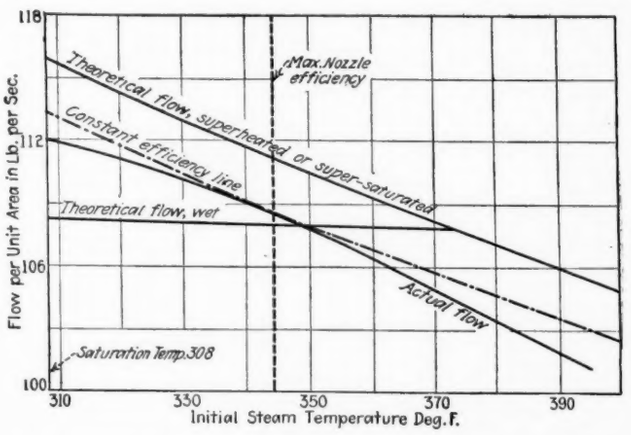
When saturated steam expands in an engine cylinder, water tends to condense out. Energy given up in doing external work represents a considerable loss of internal heat. Although pressure falls during expansion, the temperature also is reduced so much that the molecular attraction becomes greater, causing some of the steam to return to liquid state.

On account of the speed with which expansion takes place in turbine nozzles, moisture does not always condense out as when expanding under similar conditions in an engine cylinder. The steam is apparently dry and cooler than it would be if expanding in a normal manner. It is also heavier per unit of volume.

When the temperature is below 32 deg., water will ordinarily freeze to the solid state. However, it is possible to cool pure distilled water below the freezing point and to keep it in the liquid state for long periods, under proper conditions. The least disturbance of these conditions causes ice crystals to form rapidly. Similarly, steam may expand so suddenly that the condensation of water into drops cannot proceed fast enough to "catch up" with the expanding steam. This is the reason for supersaturated steam.

It seems in some nozzles that steam expands so quickly when it reaches the lower pressure where moisture ordinarily occurs that there has not been time for the water drops to form. The steam actually is dry, cooler and heavier per unit of volume than normal. After it has traveled farther, the time may be sufficient for the moisture to condense, so that the vapor regains its normal temperature and density as well. When water condenses it gives up the latent heat, thus restoring the normal temperature, which is higher than that of supersaturation. Other peculiar effects are that nozzles discharging supersaturated or under cooled steam may pass 3 to 5 per cent greater weight than for normal steam; also less work is available when expanding to the undercooled condition.

If dry saturated steam without moisture and no superheat is admitted to an engine cylinder in this condition and then allowed to expand normally without addition of heat, water will condense out as expansion proceeds. If a sufficiently high degree of superheat is employed initially, however, the steam will still be superheated at the end of the expansion. No water will condense, and expansion will be like that for a perfect gas.



How nozzle discharge varies for 76 lb. abs. admission pressure and varying superheat

It is also possible to combine the two states. If less superheat is employed, part of the expansion may be as a perfect gas, and the remainder as saturated or partly wet steam.

Supersaturated steam is assumed to behave like a perfect gas as in the case of steam being superheated throughout expansion. If a nozzle without losses be employed for expansion from superheated to the saturated state, the supersaturation or undercooling will begin at the pressure that normally marks the beginning of condensation.

The pressure at the end of the undercooled condition will not be less than 54.5 per cent of the pressure where moisture usually appears. For example, assume steam at 150 lb. abs. expanding in an engine cylinder to atmospheric pressure. Suppose it were superheated sufficiently so that the saturation point, or condition of no superheat, came at 100 lb. abs. Water would continue to condense during the remainder of the expansion, such as at 90 lb. absolute.

Assume, however, that the same steam was expanded

in a nozzle without losses. Water would not condense at 90 lb. abs. as before, and it would not be expected until some pressure close to 54.5 lb. abs. was reached.

For initially saturated steam in normal expansion without friction losses the critical pressure is assumed to be 57.7 per cent of the absolute initial pressure, so that 100 lb. abs. saturated steam expanding thus would reach its critical value at 57.7 lb. abs. for which a convergent nozzle is required. For greater expansion beyond the "critical" point, such as to 25 lb. abs., a divergent nozzle would have to be added, as a convergent nozzle alone would not expand farther.

Expansion of superheated or undercooled steam without losses is considered to follow the law $PV^{1.3} = C$, where P and V represent the absolute pressure and volume per pound, while C is a constant depending on initial conditions. The critical discharge pressure which gives the maximum velocity obtainable at the outlet of a convergent nozzle is 54.5 per cent of the absolute pressure of the steam supplied to the nozzle. The discharge in pounds per second for a perfect nozzle is according to the law

$$W = 0.3155A\sqrt{\frac{P_1}{V_1}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where

A = Area of throat, sq.ft.
P_1 = Initial absolute pressure, lb. per sq.in. abs.
V_1 = Initial volume of 1 lb. steam, cu.ft.

For normal expansion from a saturated condition without losses the law $PV^{1.135} = C$ is approximately followed. The discharge is then

$$W = 0.3004A\sqrt{\frac{P_1}{V_1}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Therefore from equations (1) and (2) it appears that normal saturated expansion (2) passes somewhat less steam through a nozzle than that for a gaseous state without condensation as in (1).

In a paper read by A. L. Mellanby at the March 11, 1925, meeting of the Institute of Chemical Engineers, England, and reported briefly in *The Engineer*, steam at 76 lb. per sq.in. abs. was supplied at various temperatures to a convergent nozzle and the weight discharged determined. The flow line, when plotted, indicated the greatest nozzle efficiency at about 345 deg. F. total temperature, or 37 deg. initial superheat, as shown in the figure. Apparently, losses are greater with superheated steam than with supersaturated. The point indicating greatest nozzle efficiency therefore is taken to represent the initial conditions that produce the most advantageous range of undercooled expansion.

The upper line shows the steam discharged at the various temperatures, calculated for the type of expansion that would occur if the steam were superheated or supersaturated throughout without nozzle losses. A line marked "constant efficiency" is drawn parallel to the upper one to indicate the flow if the nozzle efficiency were constant at the best value obtained in the test. In other words it is drawn tangent to the flow curve, and parallel to the upper line.

At temperatures above or below 345 deg. F. the actual nozzle efficiency tends to decrease, indicating that moisture at lower temperatures lowers the nozzle efficiency, and higher superheat increases losses as well as tending to cut down the undercooling effect. The discharge for saturated steam in normal expansion is also indicated by the horizontal line marked "theoretical flow, net." Actual flow is nearly 4 per cent more than for initially saturated steam.

Boiler Performance Chart

By G. H. Sheasely

BASED, as it is, solely upon the values given in Marks and Davis' steam tables, the chart for boiler performance on the opposite page embodies no new or revolutionary principles, but is rather an arrangement of these values in such a manner as it is believed will cover a maximum range of operating conditions within a minimum of chart space.

The method of reading the chart is illusutrated by the arrows for the following set of conditions. Gage pressure, 170 lb.; steam temperature, 575 deg. F.; feed-water temperature, 190 deg., actual evaporation, 9 lb. of water per pound of coal; calorific or heat value of coal, 14,000 B.t.u.; cost of coal, $6 per gross ton.

Starting from 170 lb. in the gage-pressure scale on the left, cross the chart horizontally to the right margin and find 375 deg. as the temperature of saturated steam corresponding to this pressure. As the actual steam temperature is 575 deg. it is evident that the superheat is 575 — 375 = 200 deg. Now on this same pressure line go back to the left to the intersection with the curve representing 200 deg. superheat and then proceed vertically up to the transfer line. Next move horizontally to the left to the intersection with the diagonal line representing 190 deg. feed-water temperature.

From this intersection go vertically upward through the factor-of-evaporation scale. Note factor, which is slightly less than 1.183, and continue to the line representing an actual evaporation of 9 lb. of water per pound of coal. Mark this point and proceed horizontally to the intersection with the diagonal line representing 14,000 B.t.u. per pound of coal. Hold this point while reading the equivalent evaporation as 10.65 lb. from the scale at the left margin. Then vertically above read the over-all efficiency as 73.7 per cent from the scale at the top margin. Now return to the marked point on the B.t.u. line and proceed to the right to the intersection with the curve representing a fuel cost of $6 per gross ton. Hold this point while reading the B.t.u. absorbed from the right marginal scale as 10,300 and vertically above read the cost of fuel per thousand pounds of equivalent steam as 25.1 cents.

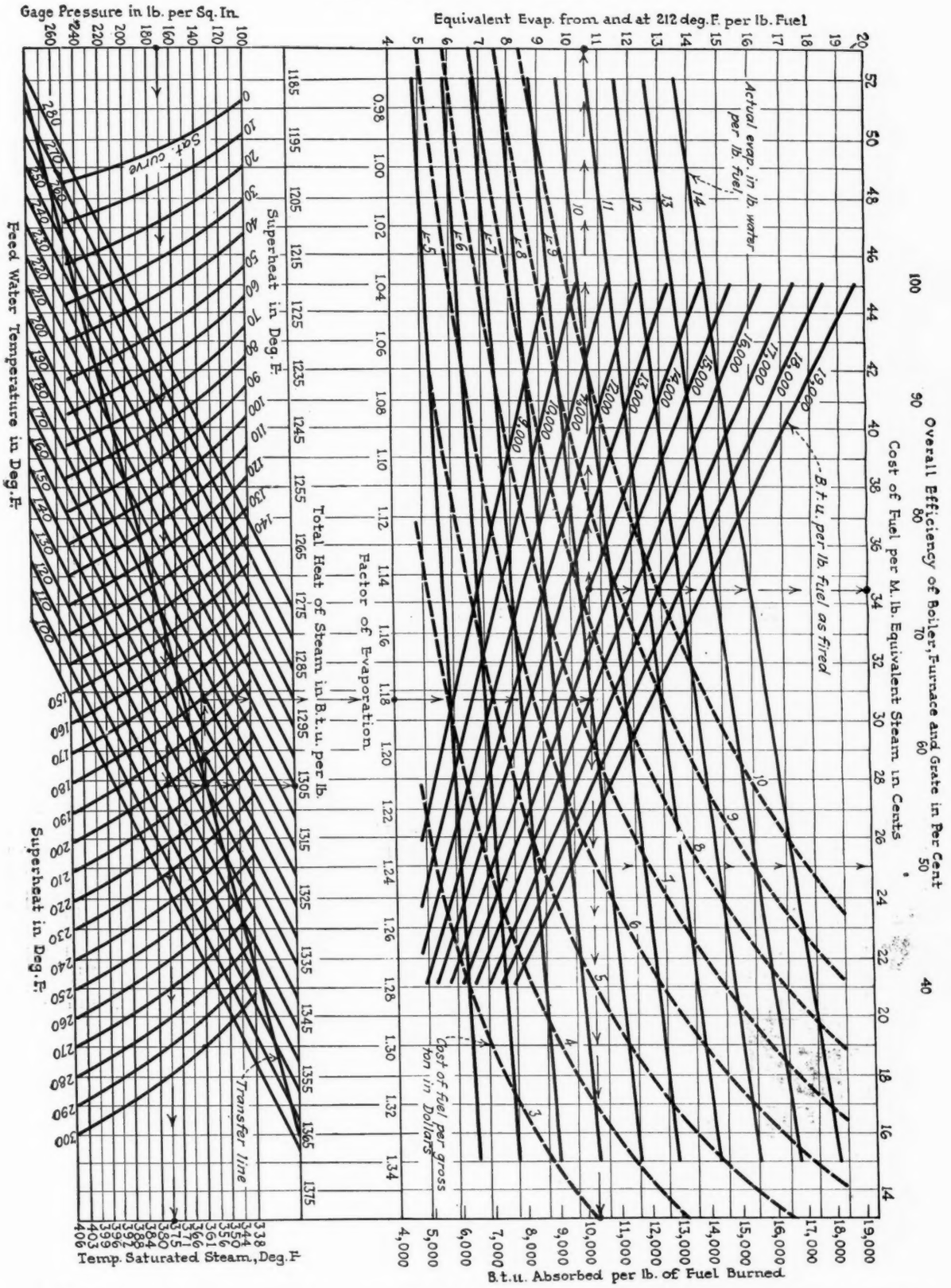
In the foregoing calculations no attempt has been made to separate the performance of boiler and superheater, although this can readily be done if desired, also that of an economizer in case one is in use.

To get the performance eliminating the economizer, take the feed temperature as that of the water leaving the economizer. In the same way the superheater may be eliminated by taking the superheat as zero.

During the last few years questions have been raised as to the safe capacity of a water-cooled transformer when operated without water. In the absence of sufficient performance data, half of full-load capacity has been considered as being safe. Manufacturers have suggested that if such a rating is desired, it will be feasible in the design of water-cooled transformers to provide for a supplementary and reduced capacity rating of 66⅔ per cent when the transformer is being operated without water. *National Electric Light Association's 1925 Electrical Apparatus Committee's Report.*

Boiler Performance Chart

DESIGNED BY G. H. SHEASELY


Gage Pressure in lb. per Sq. In.
Equivalent Evap. from and at 212 deg. F. per lb. Fuel
Actual evap. in lb. water per lb. fuel
B.t.u. per lb. fuel as fired
Overall Efficiency of Boiler, Furnace and Grate in Per Cent
Cost of Fuel per M. lb. Equivalent Steam, in Cents
Sat. curve
Superheat in Deg. F.
Total Heat of Steam in B.t.u. per lb.
Factor of Evaporation
Feed Water Temperature in Deg. F.
Superheat in Deg. F.
Transfer line
Cost of fuel per gross ton in Dollars
Temp. Saturated Steam, Deg. F.
B.t.u. Absorbed per lb. of Fuel Burned

Given steam temperature and pressure, feed temperature, heat value of fuel and actual evaporation per pound of fuel, chart gives over-all efficiency and cost of fuel per thousand pounds of steam, also temperature of saturated steam, heat content of steam, factor of evaporation, equivalent evaporation and B.t.u. absorbed per pound of fuel burned. See facing page for instructions.

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Interconnection of Industrial and Public Utility Plants

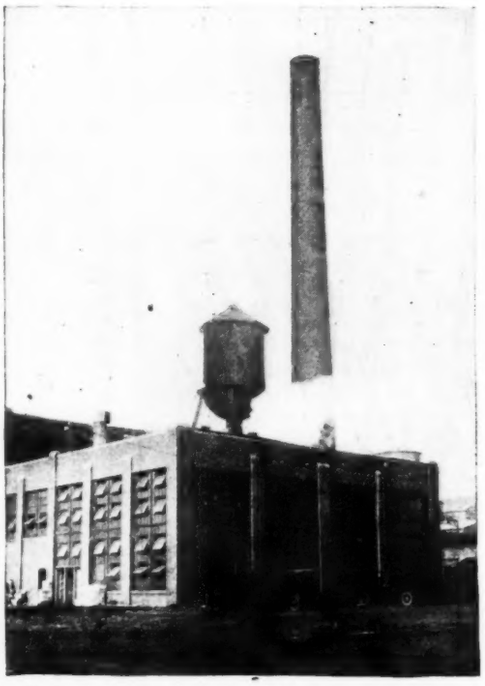


Fig. 1 (above)—The Walsh power plant

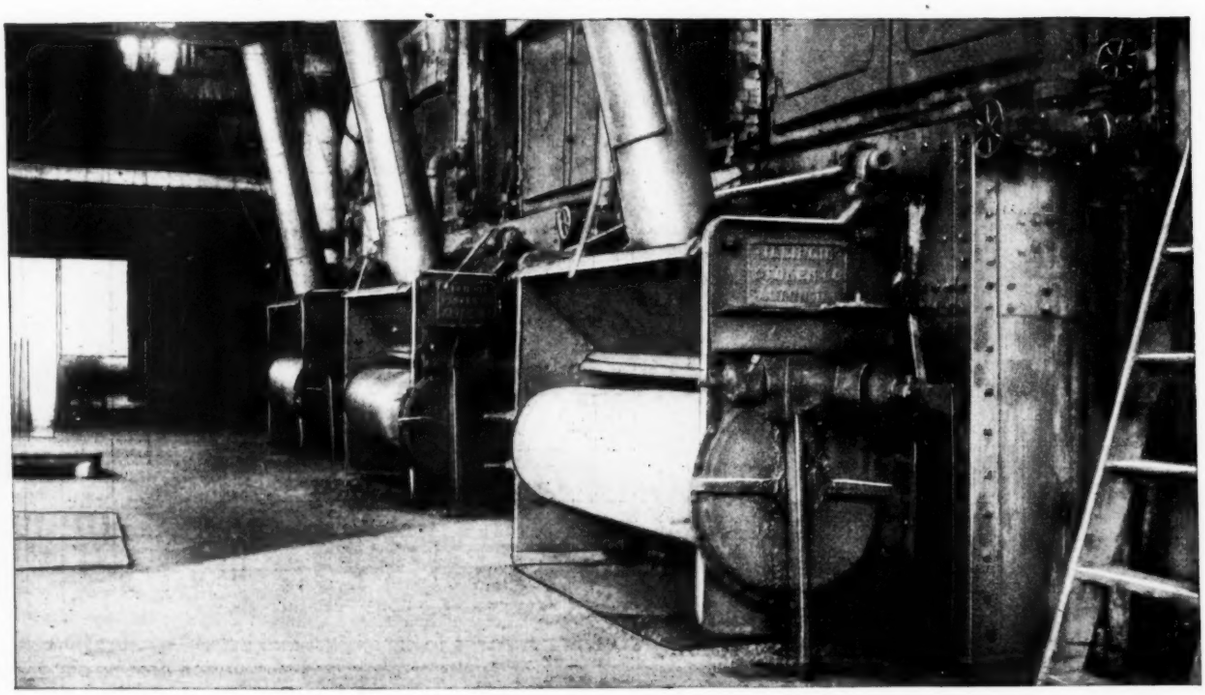
Walsh Fire Clay Products Co.'s Power Plant

The Walsh Fire Clay Products Co., at its Vandalia, Mo., plant has a connection with the Missouri Power & Light Co. whereby electric power is interchanged between the two plants. During the brick plant's peak load energy is taken from the electric transmission line, and during the evening current is pumped back into the transmission line. Usually, the net difference in a month is small.

Three vertical water-tube boilers equipped with traveling chain grates supply steam to a Corliss engine direct connected to a 500-kw. 480-volt alternator and to a 4-valve engine direct connected to a 200-kw. generator.

The power plant is a brick and steel structure, with the engine room lined with white enamel tile. At present a substation is being built so that connection can be made with the Keokuk hydro-electric system.

Fig. 2 (below)—The water-tube boilers are fitted with chain grates



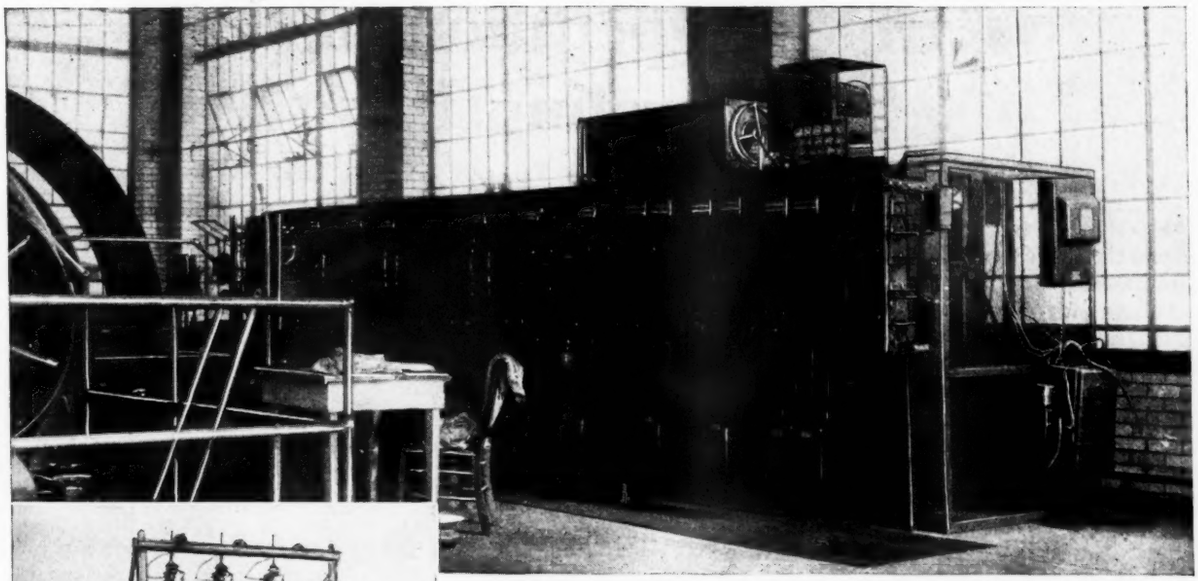


Fig. 3 (above)—Switchboard contains interconnection switches

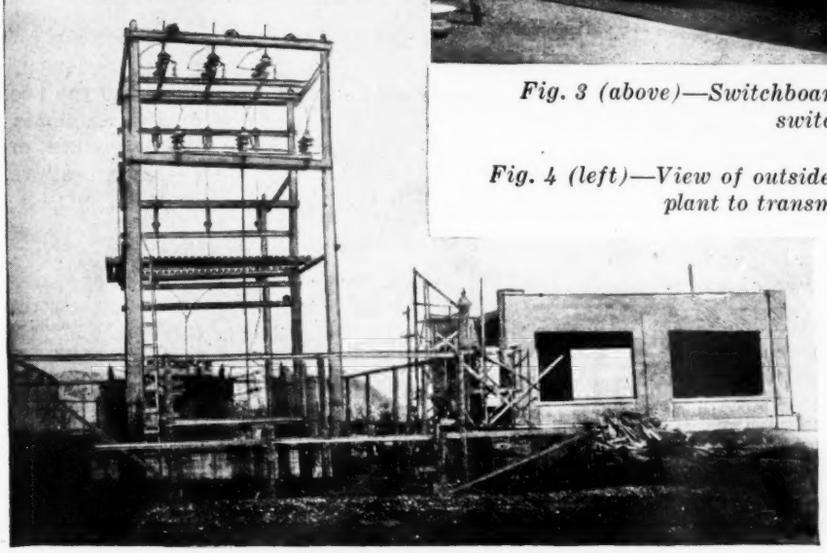


Fig. 4 (left)—View of outside substation connecting power plant to transmission system

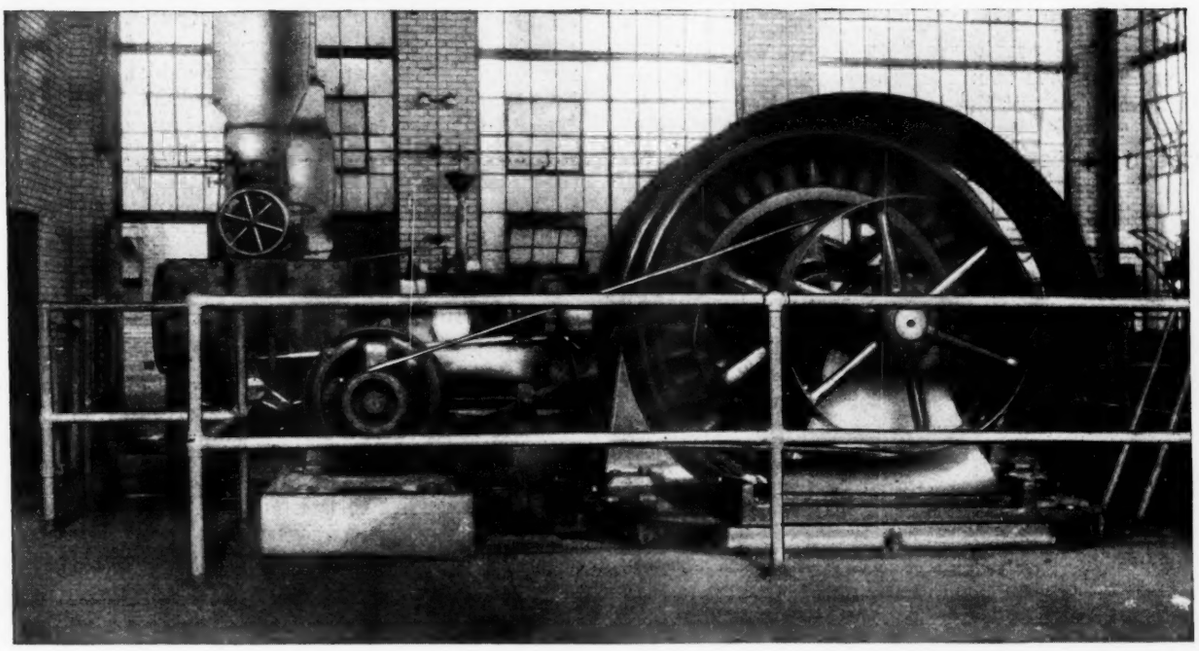


Fig. 5 (below)—200-kw. 4-valve engine-generator set

Careless Operation in the Refrigerating Plant

By ROLAND L. TULLIS

THOSE who are closely identified with the power-plant field, claim with much truth that the great drawback is a lack of thoroughness on the part of the operator. Although the plant be designed along approved lines, it is by no means infrequent to find it in trouble due to a careless operator. Many engineers can recall incidents to bear out this statement.

For example, I once had occasion to install a small refrigeration plant of 10-ton capacity. The refrigeration part of the system consisted of a number of cooling boxes in the kitchen where meat and other provisions were stored. The cooling coils were constructed of bent pipe; that is, all the coils were bent, formed and welded in the shops, being installed in units in the boxes. It was a direct-expansion system, and all piping wherever possible was welded.

When the coils were all installed in the refrigerators and the lines connecting with the compressor completed, we started the compressor and applied an air pressure of 150 lb. to test for leaks. We used the soap-lather method of testing, applying the lather to all the welds and joints; wherever a leak was discovered, it was marked and the welder came along later and remedied it.

Air Left in System

When all the visible leaks were repaired, we decided to test out still further by leaving the air pressure on the coils during the night. The main stop valve on the return line or suction from the newly installed boxes was closed tight and also the expansion valves.

Connected to the system was a small brine tank containing twenty-four 100-lb. ice cans. This part of the system had previously been tested with air pressure and had been found tight. Ice was badly needed, so we decided to put the ice-making part of the system to work at once, but leave the air pressure on the refrigerator coils. As the first step the air from that ice-making part of the system was removed, the purge valve on the condenser was opened, and most of the air allowed to escape; then the remaining air was pumped out with the compressor, pulling down to a 20-in. vacuum to make sure that all of the air was expelled. After this was accomplished, the king valve on the ammonia receiver was opened and the brine tank and compressor put in service.

The plant ran satisfactorily for the rest of the day. At nine o'clock the brine temperature was down to 14 deg. F. and we decided to shut the compressor down for the rest of the night. When the shift engineer attempted to start the compressor the next morning, he was surprised to find that as soon as the compressor was started and had run for a few minutes, the condenser pressure climbed up to a point where the automatic pressure switch released and stopped the compressor motor. Examination showed that the circulating water was flowing freely through the double-pipe condenser, all the valves were properly opened, and everything appeared to be in proper condition. Again the compressor was started, but the condenser pressure climbed to 230 lb., and the pressure switch released. The operating engineer maintained that the discharge line from the compressor must be stopped up or that someone must have left a blind gasket in one of the flanges. Either was impossible, for the plant had operated satisfactorily the previous day. Finally, I was struck by an idea and took a walk up to the second floor where the storage boxes were located. As I had surmised, someone during the night had opened one of the return valves on the refrigerator coils and this had released the compressed air into the rest of the system, consequently the condensers had become filled with non-condensable air and the pressure of this added to the pressure of the ammonia gas, accounted for the exceedingly high pressure on the machine. As soon as the condensers were properly purged, the plant was again in operation.

Condenser Pressure Rises

One day, a few months later, a sudden and alarming rise in the ammonia condenser pressure occurred. The pressure on the high side began to climb and in a few seconds had increased until the pressure switch stopped the motor. But most surprising of all, the pressure continued to climb rapidly even after the compressor had stopped. Here was a situation that called for immediate action. The condenser pressure had increased to over 300 lb. and in a few minutes something would let loose. I rushed to the double-pipe condenser and placed my hand on the pipes. It almost burned my hand, although under normal conditions the outside surface of a double-pipe ammonia condenser is hardly more than lukewarm. Hot water evidently was getting into the condenser and the water-inlet valve had to be closed to keep this out of the condenser. The machine was already stopped and I opened the bypass valve on the machine so that some of the gas in the high-pressure side could enter the low-pressure side and relieve the pressure on the condenser.

The next move was to find out where the hot water was coming from and how it was getting into the condensers. In the same plant was a small boiler, fired with natural gas and used as a water heater; that is, water entered the boiler from the city mains where it was heated and circulated throughout the institution. The ammonia condensers received their supply of cold water from the same main line that the boiler did, and whoever erected the piping had failed to put a check valve on the inlet to the boiler. Very little hot water was being used, and there was a little more fire than necessary under the boiler. Consequently, the boiler pressure had risen above the water-main pressure and hot water forced back into the supply line, had flowed into the ammonia condensers with almost disastrous results. A good check valve on the inlet line to the boiler prevented further trouble from this source.

Side-Suction Centrifugal Pumps More Efficient for Small Capacity

FOR small discharge rates the side-suction centrifugal pump is more efficient than the double-suction type, and with appropriate thrust bearings and piping connections the side-suction design is equally convenient.

By RUSSELL K. ANNIS

ASIDE from the fact that the side-suction type of centrifugal pump is cheaper than the double-suction type, it has a distinct advantage under certain conditions, which is often overlooked. Before discussing this advantage, let us see how the disadvantages of the side-suction type may be overcome.

It is generally admitted that the double-suction design is a higher-grade pump than the side-suction. This is because it is hydraulically balanced, readily accessible for cleaning and repairs, compact and self-contained. It is not claimed that the side-suction pump can equal the double-suction in all these points, but it can be made to overcome its inherent handicaps to a great extent and give efficient and satisfactory service.

Hydraulic Balancing of Double-Suction Type Nearly Perfect

With regard to hydraulic balancing the balance of the double-suction type is very nearly perfect, the degree of perfection depending on the accuracy with which the castings for the impeller and the casing are symmetrical. This fact is indicated by the plan view of a double-suction pump shown in Fig. 1. The suction divides equally into two streams which enter the impeller axially from opposite directions, producing equal and opposite thrust effects. The streams then re-unite within the impeller and leave through the discharge passage in a single stream. From this it is evident that theoretically there can be no thrust, regardless of the rate at which the water is flowing, the suction lift, or the head against which the pump is working. It usually works out that the thrust is very slight and can be taken care of by ordinary shaft collars; or, if ball bearings are used, by the radial type of ball bearing.

With the side-suction pump thrust is a more important item. A sealing ring on the back of the impeller does not produce a balance at all capacities, and it is necessary to use a substantial thrust bearing. For very small pumps a shaft collar may be used, but the results are doubtful. A marine thrust bearing is better even in a small pump, and for larger pumps a ball thrust bearing is perhaps the best. The Kingsbury thrust bearing will also give excellent service, but would be used only on large pumps. The main point to remember is that the thrust of a side-suction pump is greater than that of a double-suction pump and should be provided for in a substantial manner.

The double-suction pump is always accessible for cleaning and repairing, by removing the top half of the casing, which exposes the impeller, stuffing boxes and all water passages of the casing itself. This is a desirable feature, and the side-suction pump, as usually installed, cannot be repaired so easily. This is shown by dotted lines at *B*, Fig. 2. In order to repair this pump, it would be necessary to remove a portion of the suction line, and in some cases, for instance where the suction pipe enters through a wall, it might be necessary to dismantle the pump to look at the impeller.

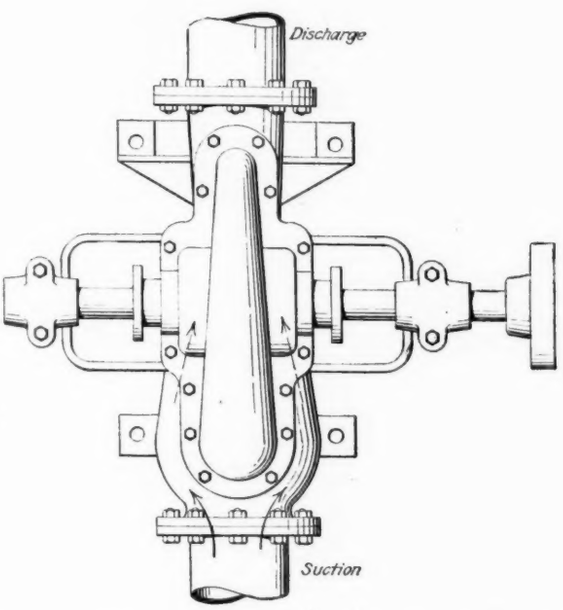


Fig. 1—Side thrusts in double-suction pump are practically balanced

This would mean the removal of the driving unit and the main bearing of the pump, leaving the casing in place.

Such a condition is entirely unnecessary and can be entirely avoided by installing as shown by the solid lines, with an elbow in the suction line. If a long-sweep elbow is used, the fluid friction losses will be negligible. The accessibility of the outfit is evident from the illustration. To inspect the impeller, it is necessary only to unbolt and swing back the casing flange, and all parts of the pump are exposed just as in a double-suction pump. For minor repairs, such as inspecting the sealing rings or cleaning the impeller inlet, the joint of the suction elbow may be broken at *J*, and the suction pipe, if it is flexible, can be swung back. In cases where the suction pipe is fixed, both joints of the elbow can be broken, giving free access to the pump. In any event the elbow in the suction

line makes it an easy task to repair, inspect, or clean a side-suction type of pump.

Where small pipes with screwed connections are used, the construction shown at *A*, Fig. 2, is recommended. Where the suction line is flexible, the union may be omitted, but it is always a convenience. Another union may be required in the discharge line. It is better to locate the union as shown than to locate it at such a point as *X*, so that the casing studs can easily be cleared.

Compactness and Solidity

It has also been stated that the double-suction design is more compact, due to the fact that in a double-suction pump the casing acts as the main frame of the pump and the bearings are part of, or are fastened to, the casing. It cannot be denied that this makes a solid unit as compared with the side-suction pump, in which the casing is overhung from the main bearing or is fastened to a common baseplate with it. Whether this compactness and solidity is an important factor depends on the individual case. A side-suction pump that is amply proportioned and provided with tenons and dowel pins, will maintain its alignment perfectly and give no trouble from this source.

Fig. 3 shows wherein the side-suction pump has a pronounced advantage, and the writer has seen many tests that corroborate the principle brought out by the curves of the two pumps. As a matter of proof, assume a curve which represents the efficiency of a double-suction pump at various capacities. Now select any pumping load such as *Q*, and project up to the curve, which gives the efficiency *E*. Since the suction stream divides equally, half the water goes through either side of the impeller and the capacity of either half is represented by $\frac{1}{2}Q$. In other words, the double-suction pump is equivalent to two single-suction pumps placed back to back. The efficiency of either half will be the same as for the whole pump, and *E'*, the efficiency of an equivalent single-suction pump at a capacity of $\frac{1}{2}Q$, will be equal to *E*. This gives a point on the single-suction curve which represents the efficiency of a side-suction pump similar to one side of the double-suction pump.

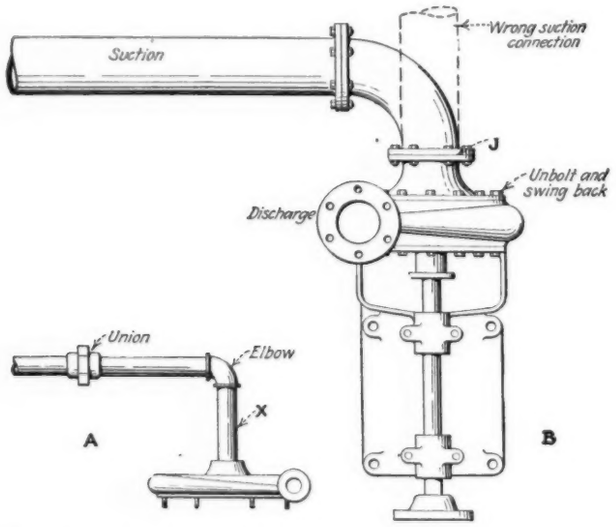


Fig. 2—Side-suction pumps should, for convenience, have suction lines with elbows

Side-Suction Type More Efficient for Small Capacities

With particular reference to the two curves it will be noticed that they cross at a point *P*. For capacities greater than *P* the efficiency of the double-suction pump is better than that of the single-suction pump, but for smaller capacities the efficiency of the single suction is better. This brings out the important fact that *for small capacities the efficiency of a side-suction pump exceeds the efficiency of a double-suction pump of similar design.*

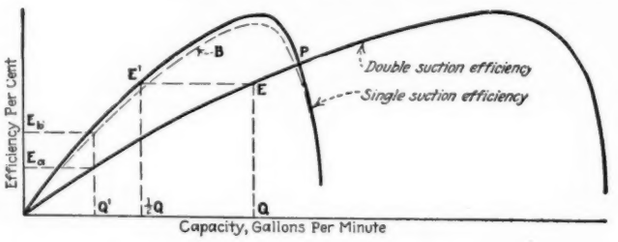


Fig. 3—For small capacities, a single-suction pump is more efficient

Comparison is made at different capacities for the reason that it is always a difficult matter to get good efficiencies from *any* centrifugal pump when small capacities are required. In order to meet a fixed head condition, it is often necessary to use a double-suction pump of large capacity and throttle back to actual capacity required. The curves show that at this reduced capacity, referred to as $\frac{1}{2}Q$, the side suction delivers the small capacity with better efficiency than the double-suction pump can develop.

As a practical matter, if two pumps were built strictly in accordance with the assumptions that have been made, there would probably result a slightly lower efficiency curve for the side-suction pump. However, for small capacities, such as *Q'*, the side-suction pump would still have a marked advantage, as indicated by the efficiencies, E_a and E_b'.

Boiler Explosion Implies Negligence

By A. L. H. Street

Under a decision of the United States District Court for the Eastern Division of Michigan, in the case of The Omar D. Conger, 1 Federal Reporter, 2d Series, 732, involving the liability of a vessel owner for damage resulting from explosion of a marine boiler, unexplained explosion of a steam boiler implies negligence. The court reaffirms the law as laid down in a cited case, a rule which seemingly applies to all sorts of steam boilers:

"In the present case the boiler which exploded was in the control of the employees of the defendant. As boilers do not usually explode when they are in a safe condition and are properly managed, the inference that this boiler was not in a safe condition, or was not properly managed, was justifiable."

The exposed surface area in a given weight of uniformly sized coal is inversely proportional to the diameters of the individual lumps or particles.

Stage Heating for Everybody

SOMETIMES innovations making for efficiency are forced to travel a thorny road before reaching the enviable state of universal adoption and approval. Not so with stage heating! Still but a few years old (neglecting isolated historic attempts along this line), stage heating is as much at home in the average large station as the boilers and turbines.

According to the recently issued heat-balance report of the N.E.L.A. Prime Movers Committee, ninety-six per cent of the stations investigated which went into operation since 1923, heat the feed water in two or more stages. Fifty-three per cent use three-stage heating, twenty-five per cent use two stages and eighteen per cent use four stages.

The survey revealed no serious trouble of any sort with the stage heaters. In view of the fact that boilers and turbines still have their little troubles after years of development, this remarkable record of stage heaters indicates a combination of a relatively easy problem (from the point of view of reliability) and competence on the part of designers and manufacturers.

There seems to be no good reason why the smaller plants, which naturally prefer to let the big fellows do the experimenting, should hesitate longer. The practice of installing at least two stages of heating even in the small industrial plant should soon become general.

Maine Breaks Away from Isolation

THE untenable position so long maintained by the State of Maine in prohibiting the exportation of power beyond its borders has at last been broken down, in one instance at least. By a vote of nine to one the people of that state on September 14 agreed to the exportation of power as a prerequisite to the Passamaquoddy tidal project.

This development, if it goes through as planned, will make available over half a million horsepower. This is too much to be absorbed by the industries of Maine, especially as most of these are now adequately served by local plants; hence the bulk of it must be utilized by the other sections of New England.

There are only a few places in the world where the rise and fall of the tides is of sufficient magnitude to warrant the necessary expenditure for tidal power on a large scale. The Bay of Fundy is one of these sites and has long been looked upon as a large potential source of power. Unfortunately, there was no local market for large blocks of power and the restrictions on exportation imposed by Maine formed a further obstacle. Now the latter has been removed, and the legislatures of both Maine and New Brunswick have granted charters for the development. There remains the financing, which will be by private capital, and the finding of suitable markets for the power. The engineering plans have already been worked out by Dexter P. Cooper, who is actively behind the project. In other words, of the three factors involved, political, engineering and commercial, the last is now the one upon which the project hinges.

But aside from the Passamaquoddy development, the action of the people of Maine is far reaching. It indicates that they are ready to break away from a policy of isolation and acknowledge that reciprocal relation between states that is so vital to economic power development and industrial progress.

Difficulties in the Designing of High-Speed Oil Engines

THE danger inherent in the presence of stores of highly inflammable fuel in the vicinity of a hot exhaust pipe has made the gasoline engine objectionable as an aircraft prime mover. The fact that such engines are almost universally used in both airplanes and dirigibles is due entirely to the absence of a suitable engine using heavy oils.

That the heavy-oil engine of the light-weight high-speed type has not come into existence is not due to the lack of effort. In fact, more than one firm has spent thousands of dollars on the attempt to design this machine, but without exception all have proved disappointing.

The failure has been attributed to the fact that the designers have attempted to produce an engine that was but a miniature of the large slow-speed oil engine. The working out of the mechanical details is not impossible, calling, in some instances, for the use of lighter materials, but the real drawback has been the problem of obtaining satisfactory oil distribution and combustion in the cylinder. Almost any type of fuel pump will accurately measure fuel charges when the amount handled per stroke is one-tenth of a cubic inch, as is the case in large units, and this amount can be more or less satisfactorily sprayed through a suitable atomizer. With a speed variation of five per cent the accuracy of the governor and fuel pumping mechanism even in large engines must be close.

In the case of engines turning at one thousand or more revolutions per minute, the volume of fuel handled per stroke is exceedingly small, and a leakage that would be unobjectionable in a pump having a larger displacement, would unbalance the cylinders to such an extent as to prove dangerous. It appears that the problem of handling the fuel cannot be solved by the use of displacement pumps. The atomizer likewise is not easily susceptible to modification to permit its successful use with small cylinders. The nozzle check valve requires a measurable period of time for closing and will dribble when used at the higher speeds. This imperfect nozzle action is undoubtedly the reason for the excessively high pressures experienced in the high-speed oil engine.

After the fuel enters the cylinder, new problems must be overcome. It is not difficult to spray an oil charge into the air charge of a large engine with sufficient energy to obtain good distribution without impingement on the cold cylinder walls. In small cylinders there is a real difficulty, due to the shorter spray path and to the higher speeds, which decrease the time available for vaporization and combustion.

Apparently, a new method of fuel handling and distribution is required before the successful high-speed engine is evolved. Probably it will be found that the fuel must be vaporized in an exterior compartment and introduced in the form of a vapor rather than as a liquid.

Germany Plays a Trick on the Coal Man

JUDGING from an article in *Commerce Reports* (Sept. 14), German industry, in its search for economy, has not been duly considerate of the coal industry. What would one think of the manners of a community where everybody got well and stayed so, putting the doctors out of a job? That's about what the Germans seem to be doing to the coal man. Quoting *Commerce Reports*,

> Germany's present coal crisis, marked by the record stocks of 10,000,000 metric tons at Ruhr dumps, by the progressive closing down of Ruhr pits, and by the dismissal of thousands of miners, is the severest in local history. This crisis is due to the greater fuel economy and an increased consumption of low-grade lignite, particularly for electrification. Great strides have been made in attaining maximum efficiency in coal burning. . . . Better utilization of the heat in the steam has also contributed to economy. . . . In 1913, when German bituminous production was about 190,000,000 tons, the lignite output was only 87,000,000 tons. Peak lignite production was reached with 137,000,000 tons in 1922, when bituminous production had declined to only 130,000,000 tons.

Yet the generation of electricity in Germany more than trebled from 1913 to 1922. Other factors contributing to this remarkable result were the rapid development of hydro-electric power and the more complete utilization of sources of waste heat.

To the extent that a big demand for coal results from a corresponding intensity of productive activities, it is an indication of general prosperity, but reduced coal demand due to better combustion, the use of low-grade substitute fuels and economy in heat utilization is certainly a good economic sign even though it may to some extent imply a temporary depression in the coal-producing industry. The production of commodities for the minimum unit cost in capital, materials and labor, is fundamental to genuine prosperity. Those nations in which this doctrine is most thoroughly applied will, other things being equal, reap the largest harvest.

Why Study?

THE N.A.S.E. is emphasizing the importance of education among its members and has elaborate plans for recognizing accomplishment.

All of this is good. No man knows all there is to know about his own job, to say nothing of the work of his official superior whose job he aspires to fill, and of his companions whose work he hopes to supervise.

But, after all, why study? Why spend the evening over a dry book, when the movies are open and the air is full of radio delights?

A common reply, especially by those who have home study courses and books to sell, is that the object is to secure a better job, to win promotion, to earn more money. Well, these *may* follow diligent study—they never will come to most men without it—but we must remember that they do not necessarily follow. One cannot secure a better job if there is no such job open. Promotion must wait upon the vacancy of the job ahead. More money can be paid only for more value, and it must be recognized that, for most jobs, there is a limit beyond which it is impossible to go.

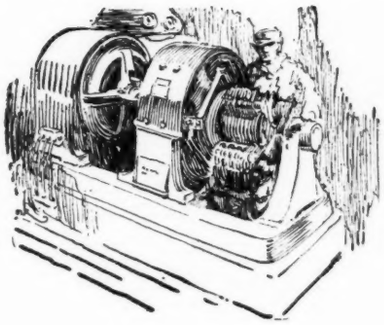
No—material advancement is the wrong motive for study. It peters out too soon. Many a man has worked hard for two or three seasons, only to stop altogether in bitter disappointment. The trouble is not with education or with conditions—the ideal is at fault.

The real reason why one should study his work is an ideal which will last for life—the ideal of making one's self a better man tomorrow than one was yesterday, to understand a little better the things one sees day by day, to do one's work ever more effectively. Not for a better job or more money, although those will come as opportunity affords; not for the vainglorious domination of one's fellows; but for simple personal self respect. To be a better man day by day, a little more helpful to the other fellow, a more intelligent assistant to the chief, a more honorable example of an engineer—that is the real reason for study.

The United States Post Office has been conducting an intensive campaign to get mail completely and correctly addressed. Merchants and business organizations have been earnestly requested to aid the post office in rendering efficient service by including in their letterheads and advertisements their complete street address and their room number in buildings. It would seem that almost any business man could see the advantage of including his specific address on his letterheads and catalogs, but long experience with handling such material convinces one that the post office authorities have a just cause for complaint. Some misguided folks feel that they will be thought important by having only Chicago or New York on their letterheads; that they are so well known that it is not necessary to give more information. If the postal authorities should give notice that they would leave mail so addressed undelivered for a day or so, probably they could effect a speedy change of heart in firms who violate such a common-sense request on the part of a long suffering department of the government.

With steam temperatures apparently limited to seven hundred or seven hundred and fifty degrees by the nature of available commercial materials, the spectacular advances just now are in pressure rather than temperature. Believing that materials may soon be available for temperatures up to nine hundred and possibly one thousand degrees, A. G. Christie and Douglas C. Turnbull, Jr., have made a study of the effect of higher steam temperatures on over-all station efficiency. Discussing the matter in the recently issued Prime Movers Committee report on "Higher Steam Pressures and Temperatures," they estimate that a four-hundred-pound, one-thousand-degree station (regenerative cycle) would equal the performance of a twelve-hundred-pound, seven-hundred-degree station. This is worth thinking about while waiting for the metallurgists to hand us suitable materials.

Practical Ideas from Practical Men



WITH a view to stimulating engineers into the habit of recording for the benefit of brother engineers, unusual occurrences, how these were met and other practical expedients adopted in the operation of their plants, Power has decided to award two cash prizes each month during 1925. One of $25 for the best and another of $15 for the second best practical letter on plant operation or practical kinks received during the month. This is in addition to payment for the contribution at space rates. The winners for August will be announced next month.

Power is pleased to announce the awards of the judges for the first and second prize contributions received during July for this department in accordance with the terms of the contest as stated above.

The first prize of $25 goes to Andrew F. Sheehan, of Holyoke, Mass., for his article on "Cutting Production Costs by Changes in the Power Plant," in the Sept. 15 issue.

The second prize of $15 goes to Thomas Pascoe, of Norway, Mich., for his article on "Replacing a Broken Piston Under Difficulties," in the Aug. 11 issue.

The judges were: (Chairman) Norman N. King, chief engineer, Singer Bldg., New York City; Willis Lawrence, mechanical engineer, Interborough Rapid Transit Co., New York City, and D. L. Fagnan, formerly refrigerating engineer, and more recently associated with the Smoot Engineering Corp., New York City.

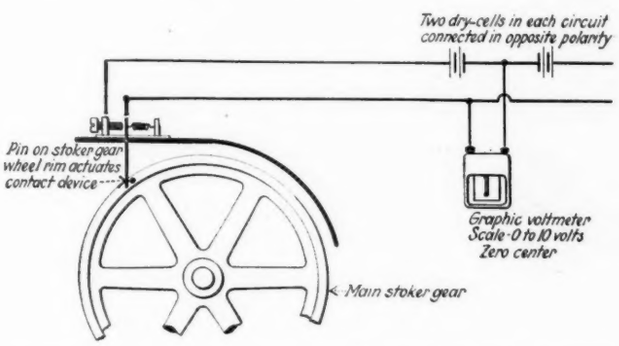
Graphic Voltmeters Used for Boiler-Plant Tests

Although the use of curve-drawing instruments for the measurement of coal and water may seem somewhat unusual, such instruments were used to good advantage in some recent plant tests.

The plant in question is operated in general upon morning and evening peaks only, the boilers being banked at the other hours of the day. Although records are kept of the total amounts of coal and water consumed, such records do not show how the consumption is distributed over a 24-hour period. To obtain such data, therefore the meters were used in the following manner:

Contact-making devices, indicated in the illustration, were installed on the guards of the main gears of two chain-grate stokers and connected through two dry cells, each to a curve-drawing voltmeter having a 10-volt scale and pointer set for zero at the middle of the scale. The dry cells were arranged with opposite polarity so that the indications for one stoker were drawn below the center and those for the other stoker by a line above the center. The contact devices were actuated by pins threaded into the rims of the stoker gears. The stokers seldom operate at exactly the same speed, but even when the indications were simultaneous, it was possible to tell that both stokers had registered an operation.

The quantities represented by a gear revolution were obtained by measuring the amount of coal from the dimensions of the stokers, height of gate setting, etc. A further check of this quantity may be made by actually weighing the amount of coal for a measured amount of grate travel or for a definite number of revolutions of the stoker gear. Although neither of these methods may be relied upon to give accurate results, on account of the variables involved, the data obtained were sufficiently accurate for the purposes desired. The advantage of this method over the one


Two dry-cells in each circuit connected in opposite polarity
Pin on stoker gear wheel rim actuates contact device
Graphic voltmeter Scale 0 to 10 volts Zero center
Main stoker gear

Graphic voltmeter records revolutions of stoker gear

employing revolution counters (which was considered) lies in the fact that the time for each revolution is registered upon the voltmeter chart.

A continuous record of the water consumption was obtained in a somewhat similar manner. At the plant in question, although water is usually supplied through a number of connections, it is possible to supply the entire amount required through one line and thus to register the entire boiler consumption on one meter. The cover of this meter was removed and a fiber block carrying two spring copper contacts was fastened to the meter head. One contact, with the end pointed, was made to bear down on the center of the 100-cu.ft. dial hand, while the other was bent in such a manner as to make contact with the hand upon each revolution. By connecting the contacts to the curve-drawing voltmeter through two dry cells, a line was drawn on the chart for each 100 cu.ft. of water used by the boilers. The use over any period of time and the quantities used for any purpose, such as blowing down the boilers, could be readily obtained. L. N. VAN HOOK.

St. Louis, Mo.

Improving the Power Factor

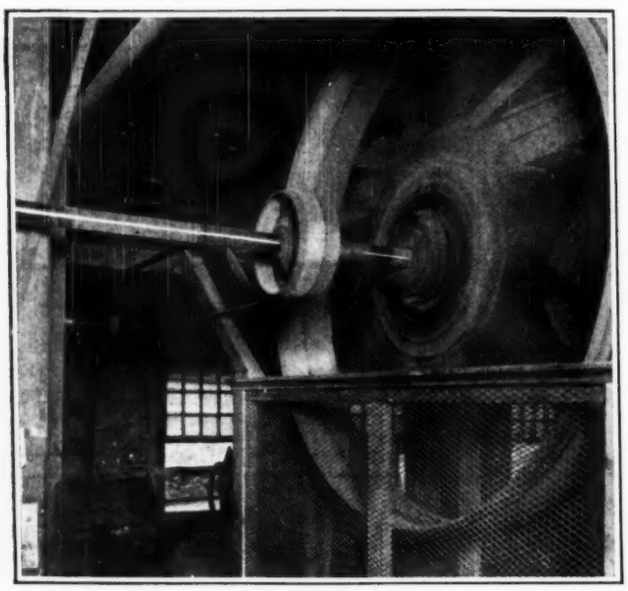
The illustration shows a 15-hp. 6-pole induction motor driving rolling barrels, a blower and a centrifugal separator, through a 90-in. steel pulley.

The drive formerly consisted of a floor-mounted 30-hp. 8-pole induction motor. Tests of this motor showed the average current input to be 11 kw. with a peak of 12.5 kw. when everything was running. The power factor averaged about 63 per cent.

The 15-hp. motor was one of a number of motors released while changing motors around and loading them up to increase the plant power factor above the penalty point without purchasing any power-factor-corrective apparatus, which was successfully accomplished, and the 30-hp. motor was required for a new drive. Hence, the only cost was for labor in changing the positions of the motors, and the following material was recovered from the former 30-hp. drive: Two jack shafts, four large hangers, one 14-in. pulley, one 18-in. pulley, two 34-in. pulleys, 35-ft. single 7-in. belt, 30-ft. single 10-in. belt and 20-ft. double 10-in. belt.

The belts were cleaned, dressed and placed in stock for other jobs, in accordance with the program adopted, and no belts have been purchased in this particular plant for over six months excepting in a few instances.

As shown in the illustration, the center to center distance between the motor and the mainshaft is 9 ft. and the speed of the motor is about 1,150 r.p.m. This drive is made by the use of a special belt with an oak leather backing having strips of chrome leather, saturated with tallow, riveted thereto. The drive has been in operation for nearly eight months; it is quiet, and not one case of trouble has been reported.



Arrangement of the new drive

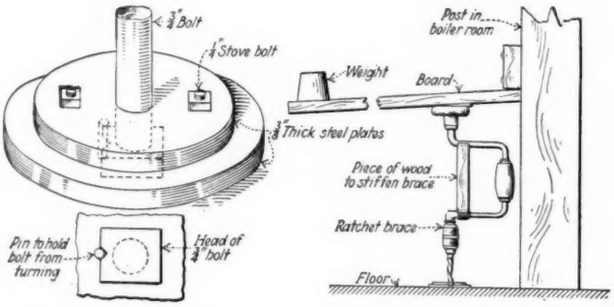
The foregoing emphasizes the importance of substituting motors before purchasing power-factor-corrective apparatus. If such apparatus had been purchased in the present case and no changes in motors had been made, the extra friction load and the unnecessary material causing it would not have been eliminated and a new 30-hp. motor would have been purchased for the new drive.

The induction motor has inherent power-factor-corrective characteristics, and the power factor of a 15-hp. motor can be increased from about 77 per cent at one-half load to about 89 per cent at full load in some cases by simply loading the motor so that it will do the work it was designed to do. By analogy there are altogether too many cases of placing No. 12 shoes on No. 6 feet. Make the shoes fit the feet. Then see the power-factor-corrective-apparatus doctor.

Waterbury, Conn. CHARLES R. UNDERHILL.

Emergency Handhole Plate Repair

Some time ago, when we were closing up one of our boilers after washing out, the fireman reported that he could not stop the handhole plate in the smokebox from leaking. Upon examining it, I found that it was cracked through in the center where the stud bolt screwed into it.



Handhole plate made from two pieces of steel bar

There was a small shop near by, but it being Sunday, the owner had gone off and no one knew when he would return. The next shop was seventy miles away, and it was essential that the boiler be in service again by 7 o'clock Monday morning. While looking around for some material to reinforce the plate, I struck upon the idea of making a new one from some ¾x6-in. steel bars that we had on hand. Accordingly, two pieces were cut out, one for the handhole plate and a smaller one to form a ring to hold the gasket in place. The only tools we had to do this with, were a hacksaw, hammer and cold chisel.

After cutting the plates to the proper size, the problem was to devise a means of drilling them for two ¼-in. bolts to hold the plates together and for the ¾-in. stud bolt. The only tools we had for drilling were a ratchet brace and some drill bits.

As it would be a difficult job to drill the holes with the brace in the usual way, we used the rigging shown at the right of the illustration. A cleat was nailed to a post in the boiler room and a board was used for a lever, sufficient weights being put on the end of the lever to feed the drill. We reinforced the frame of the brace with a piece of wood notched at each end to prevent its springing.

To prevent the stud bolt from turning, a dowel pin, made from a large wire nail, was inserted in the plate close to the bolt hole and a notch was cut in one side of the bolt head to fit over the pin as shown. The job was completed and the boiler filled with water ready for firing up, by 10 o'clock that night. The plate has been in place about six months and has given no trouble.

Jacksonville, Fla. FRED E. CUPPER.

Saving Fuel in Textile Plants

There are many opportunities for reduction of the fuel costs in the older boiler plants that are not apparent at first glance but can be found by close study of conditions. These conditions are found mostly in the small and medium-sized plants and in industries where large amounts of process steam are required, such as paper mills and certain types of textile plants.

Upon accepting the position of engineer-in-charge of a paper-mill power plant some years ago, my first step was to search for possible ways to save coal. Noting that a large quantity of live steam was required in the process of drying paper, it seemed that there was an opportunity for making a considerable fuel saving. When I entered the engine room, I asked the watch engineer how much steam was used in the driers and was informed that it was from 5,000 to 6,000 lb. per hour at 10-lb. pressure. The total steam flow was 21,000 lb. per hour as indicated by a meter on the feed line to the boilers.

The main engine was a simple Corliss and was run condensing, while the two paper machines were driven by two non-condensing four-valve engines. The boiler equipment consisted of four horizontal return-tubular boilers operated at 110-lb. pressure and were hand fired. On the second day, in answer to my inquiry as to any attempt having been made to use exhaust steam in the driers and thus save a considerable quantity of live steam, the watch engineer stated that it had been the intention to pipe up the exhaust of the small engines to the driers, but after making a survey of things, the management found that most of the exhaust was being used to heat the feed water and no real saving could be made, for the reduction in live-steam consumption would be offset by the reduction in feed-water temperature.

There was no chance, I was informed, of persuading the company to install an economizer to heat the feed water, for two different chiefs had tried to persuade the officials to make the investment, but they would not lay out any more money on the power plant, although large sums were spent on experiments in paper making.

This put a damper on my first idea right away, but I felt that there must be some sources of waste that could be checked inexpensively, as the coal consumption was 1¼ tons per ton of paper produced.

I indicated the main unit and found that the average load was 584 hp., and as the cutoff was at about one-third stroke, the water rate was naturally high. Next, the paper-machine engines were indicated and the largest one showed 74 hp. and the other 52 hp. I estimated as closely as possible the steam consumption of the various units, rating the main engine at 20 lb. per horsepower, the steam used 11,680 lb. per hour; the small engines 28 lb. per horsepower or 3,528 lb. per hour; 5,000 lb. of live steam to the driers and the balance of 800 lb. to the condenser and the boiler-feed pump.

The small engines exhausted into the feed-water heater and the slight excess went to the atmosphere, the back-pressure valve being set at 4 lb. gage. The feed pump exhausted to the heater and the condenser pump exhausted into the condenser. The condensation from the paper machines was piped from the steam traps under the machine back to an old bleach boiler, which was used as a receiving tank for drips and makeup water. About 15,000 lb. of makeup at 60 deg. F. was taken per hour from the city water main, and the rest of the boiler feed consisted of condensate from the heater and driers. The hot-water drips raised the temperature in the tank to about 75 deg. F., and the heater heated the feed to 212 deg. in an open heater.

Looking over the traps under the paper machines one day, I noticed an extra pipe line leading from the discharge side of the traps through the building wall. Going into the machine room, I saw the machine tender manipulating a valve on this line by means of an extension stem in the floor, and he stated that the paper would not dry with this valve shut and that considerable steam and water had to be blown out through this line in order to keep the driers well drained. On tracing the regular trap discharge line to the receiver tank, I found that there was a length of 1-in. pipe in the line which was 1½ in. the rest of the way. Evidently, the reason the capacity of the pipe was not sufficient, was this reduction of area.

This condition was remedied without delay and the valve on the outdoor line was sealed shut. The tank temperature increased to 102 deg. F. due to the increased flow of condensation and reduction of cold makeup, and the steam requirements of the heater were reduced.

The pipe used to repair the drip line had been procured from the scrap pile in the yard, as the management would order no pipe unless a serious emergency arose. There was an old closed heater in the scrap pile which had been used previous to the installation of the open heater, the latter having been installed for the purpose of deaërating the water and eliminating feedwater troubles.

The old heater suggested an idea which was applied the following Sunday when the plant was shut down. We placed this heater in the exhaust line of the main engine and piped our makeup water through the coil, the drip going to the condenser. As 24 in. of vacuum was the most that could be obtained with so small a condenser, we were satisfied to have the feed water reach 131 deg. F. and the makeup entering the tank 71 deg. hotter than it had been, making the tank temperature 155 deg. F. With the feed entering the heater at 155 deg. F., the 800 lb. of steam used by the condenser and feed pump was enough to supply the open heater, which permitted the use of the exhaust of the small engines in the driers. Consequently, the exhaust of the condenser pump was led into the feed-water heater and the exhaust line from the engines removed.

This plan reduced the quantity of live steam going to the driers, and the feed-water meter showed a reduction of 3,400 lb. per hour in the load on the boilers. With the reduced amount of feed to be heated, the exhaust of the two pumps, around 900 lb. per hour since the steam rate of the condenser pump increased when operated non-condensing, was sufficient to give a temperature of 212 deg., the tank temperature finally being brought up to 161 deg. by the reduction of 3,400 lb. in quantity of makeup required.

This saving amounted to 5 tons per day and was accomplished without a dollar being spent on new equipment and with less than $100 for labor, all pipe and fittings being second-hand material already within the plant. With an operating schedule of 25 days per month and coal at $6, the operating costs were cut $750 a month in a plant that had been considered hopeless from the viewpoint of operating economy.

J. A. MADSEN.
Chicopee, Mass.

Comments from Readers

High-Efficiency Pumping Engine

In the July 7 issue Prof. J. C. Dijxhoorn describes a so-called "high-efficiency" pumping engine. The term high-efficiency probably refers to the low steam consumption per indicated horsepower (9.59 lb.), as the over-all efficiency, that is, water horsepower ÷ indicated horsepower equals 27.5 per cent.

Undoubtedly, the mechanical efficiency of this complicated engine will be less than that of an ordinary unaflow engine. Mr. Dijxhoorn does not tell us the steam consumption per brake horsepower. The steam consumption per water horsepower is very high, about 35 pounds.

The pump data, although important, are not given, so we know nothing about the head for which the pump is designed. The heads, or lift of the pumps given in the article, vary from 1 ft. 10⅛ in. to 2 ft. ⅜ in., very unfavorable operating conditions.

I should like to know why Professor Dijxhoorn considers 27.5 per cent as high-efficiency for this installation, as large modern centrifugal pumps have efficiencies from 75 to 82 per cent, sometimes 85 per cent, under the conditions for which they are designed.

East Pittsburgh, Pa. G. VAN DEN BERG.

Measuring Coal on Traveling-Grate Stokers

With reference to the letter of J. W. Hogg in the July 14 issue, discussing my comments on J. R. Darnell's article, "Measuring Coal on a Traveling-Grate Stoker," which appeared in the April 21 issue, he says that in his opinion the volumetric method of measuring coal is as accurate as actual weighing and that exact measurements are neither attainable nor necessary.

While any open-minded man familiar with the subject will concede the accuracy and simplicity of the volumetric measurement of coal, we cannot afford to lose sight of the fact that no matter how correct and rational the method may be, the accuracy of results is dependent upon the accuracy of the measurement observations, and that while we are not aiming at results accurate within a fraction of one per cent, there is a limit as to how coarse measurements may be made and still yield results of value. An accuracy within 2½ per cent is generally considered satisfactory; in some instances an accuracy of 5 per cent may be acceptable. But beyond this, results cannot be seriously considered, for they do more harm than good. Such approximate measurements and records are used by a certain type of power-plant operators who grin with great satisfaction when the "records" show favorable performance, even if the showing is "too good to be true."

If, however, the performance shown by those "records" is not favorable, the matter is dismissed with the remark, "You cannot go by these records, they are only approximate," instead of taking the trouble of locating the reason for the unsatisfactory performance and remedying it. An idea of what approximate records do may be obtained from the following case:

In a large industrial plant the power-house records showed the balance of coal on hand to be some 31,000 tons. The coal bunker having a maximum capacity of 20,000 tons was a little over half full, the coal pile under the piler contained about 7,000 tons, and there were several smaller piles, aggregating some 500 tons, scattered through the yards. It was evident that the amount of coal on hand was considerably less than that shown by the records. A careful inventory was taken with the result that some 10,000 tons of coal were "written off" the books. The additional charge of some $40,000 for fuel gave the cost of power generation figures an entirely different aspect. Careful tests were carried out to determine the cause of the high cost and improvements made, which eventually brought about an annual saving of over 20,000 tons of coal.

If Mr. Hogg can mention some useful purpose approximate records will serve, I feel certain the readers of *Power* will be glad to know it. Incidentally, he might tell us why approximate records should be used, when accurate records cost no more, or only a trifle more at least.

Mr. Hogg places a flow meter in the same class with a revolution counter attached to a traveling grate. He would also have us believe, that since no power-house measurements are exact and power-house records are not to be taken too seriously, a revolution counter attached to a traveling grate is satisfactory.

It is a pity that the well-intended cautioning regarding the limitations of power-house measurements and records has been clung to by inefficient operators as a cloak for their indifference and inefficiency. In my opinion, it is the plain duty of the power-house operator to see that his instruments are properly installed and maintained, that they are calibrated at frequent intervals. It is his duty to know the limitations of his instruments and get the most out of them; it is his duty to have faith in his instruments and records and use them to the utmost advantage, instead of permitting them to deteriorate and disregarding their records with a cynical remark, "They are not exact, anyway." Mr. Hogg seems to base his opinions on beliefs. He does not state whether or not he knows from personal experience or experience of authoritative persons, that a revolution counter attached to traveling grate yields sufficiently accurate (within 5 per cent or better) results. The question arises how much beliefs count for in power-plant work. The belief that the power is off, that the valve is shut, that the block has been removed from the safety valve after the hydrostatic test has been completed, like the belief that the gun was not loaded, has proved disastrous in many instances. E. OGUR.

New York City.

Producer Gas for Desert Regions

Referring to the letter of L. D. Anderson in the May 5 issue, on "Producer Gas for Desert Regions," he seems to be under the impression that an engine for operation on producer gas must be designed for this particular fuel alone and that engines operating on blast-furnace gas are unsuitable. This seems to be rather a popular fallacy. Practically any engine that will operate on blast-furnace gas will operate equally well from a producer-gas plant. The only point to be taken into consideration is the allowable compression. Blast-furnace gas being "leaner" than that obtained from a producer, a higher compression is possible without fear of preignition. The values are in the vicinity of: Producer gas, 165 lb. per sq.in. maximum; blast-furnace gas, 190 lb. per sq.in. maximum. A good value for normal operation in the case of producer gas is about 140 lb. per sq.in., and few engines operating from a blast furnace exceed this value in normal operation. Hence, I should recommend Mr. Anderson to any reputable manufacturer of engines normally operating on blast-furnace gas.

With regard to first cost—complete plant—this will probably be greater than that of a steam plant of similar capacity, but as considerably higher over-all efficiency is obtained, especially in the case of small plants, the actual cost per kilowatt-hour should be considerably lower. Another factor that may be of interest is that after being shut down for, say, 48 hours a producer-gas-electric plant can be got into operation at full rating in slightly over ten minutes.

Coal consumption will be roughly 1.4 lb. per h.hp.-hr. at full load.

A further advantage and of considerable importance in desert regions is that water may be of practically any quality for cooling and washing and, moreover, can be used over and over again, the loss being practically negligible.

JAMES F. EDGELL.

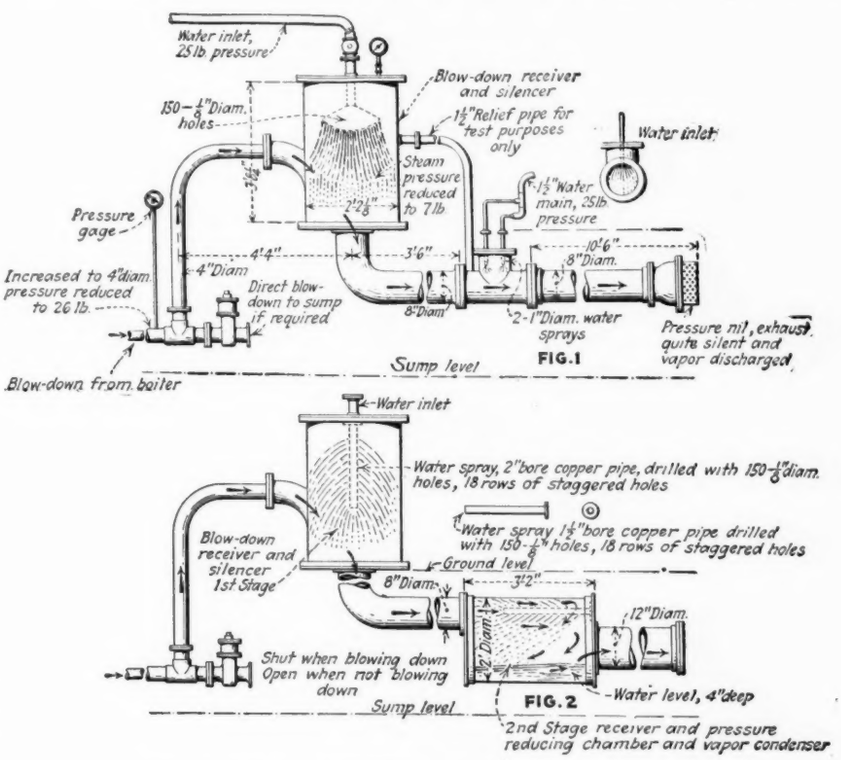
Waldon, Essex, England.

Blowoff Tank for Battery of Boilers

Several months ago an inquiry appeared in the Questions and Answers section, as to the proper size of a blowoff tank for a battery of eight boilers. A steel tank 5 ft. in diameter by 20 ft. long was proposed, with a manhole and light loose cover on the top with an escape pipe for vapor twice the diameter of the inlet pipe. It was also suggested that the blowoff connection be made at the top, and the discharge connection 20 in. from the bottom, the discharge to have an inside pipe leading down to within 6 in. of the bottom to keep the outlet sealed. This arrangement might be satisfactory in most cases, but some installations require special fittings to eliminate the noise and vapor.

About six months ago my attention was turned to experimenting with a blowdown for a battery of seven 4,000-sq.ft. boilers as the noise from blowing down was disturbing the residents of the bungalow adjacent to the power house.

The boilers are blown down from 155 lb. pressure to 135 lb. through a 3-in. pipe. The arrangement shown in Fig. 1 was the first design. Pressure-gage readings were taken showing 26 lb. ahead of the receiver with 7 lb. in the receiver when blowing down from 155 lb. The strainer from an old foot valve was fitted at the discharge end to break up and spread the vapor. The water-condensing sprays operated at 25 lb. pressure. The result of the test was satisfactory, as the steam was not only reduced from 155 lb. to 7 lb., but the volume of vapor was decreased by the condensing sprays and the discharge was so silent that it could not be heard 10 ft. away from the receiver.


Water inlet, 25 lb. pressure
Blow-down receiver and silencer
150—1" Diam. holes
1½" Relief pipe for test purposes only
Water inlet
Steam pressure reduced to 7 lb
1'2⅜"
1½" Water main, 25 lb. pressure
Pressure gage
4'4"
3'6"
10'6"
8" Diam.
4" Diam
Increased to 4" diam. pressure reduced to 26 lb.
Direct blow-down to sump if required
8" Diam
2-1" Diam. water sprays
Pressure nil, exhaust quite silent and vapor discharged
Sump level
FIG. 1
Blow-down from boiler
Water inlet
Water spray, 2" bore copper pipe, drilled with 150-⅛" diam. holes, 18 rows of staggered holes
Water spray 1½" bore copper pipe drilled with 150-⅛" holes, 18 rows of staggered holes
Blow-down receiver and silencer 1st Stage
Ground level
8" Diam.
3'2"
12" Diam.
8" Diam.
Shut when blowing down Open when not blowing down
Water level, 4" deep
Sump level
FIG. 2
2nd Stage receiver and pressure reducing chamber and vapor condenser

Figs. 1 and 2—Arrangements of blowdown tank to eliminate noise and vapor

The arrangement shown in Fig. 2 was then tried, which has a second-stage receiver with an improved type of water-condensing spray fitted to both stages. This is an improvement on the arrangement shown in Fig. 1, as it gives 6 lb. in the first stage and zero pressure in the second. The offset inlet and outlet give the water from the sprays a whirling motion and it mixes with the blowdown so thoroughly that the velocity and vapor are so considerably reduced as to be negligible and perfectly silent. After the boilers are blown down, the valve ahead of the receiver is opened to allow all water to escape from the pipe into the main drain. Water hammer cannot occur, as the pipes are always empty. This arrangement has been in operation for more than three months and is used daily.

Moghalpura, Lahore, India. H. B. ADAMS,
Assistant Electrical Engineer,
Indian State N. W. Railways.

Energy Storage

In the June 30 issue, Mr. Lagerquist invites comment on his proposal to store energy in a power station by dissociating hydrogen and oxygen by electrolysis, storing them in tanks and burning them in the superheating section of the boiler to help during peak load.

I am afraid this suggestion would not stand a searching analysis. The converting of heat into mechanical energy is unfortunately one of the least efficient of all the conversions of energy from one form into another. The first great loss would occur, when the heat of combination, which is at a temperature of about 5,000 deg. F., is degraded to the temperature of the superheated steam, say 700 deg. F. The fact is, that the boiler is the principal source of the thermal inefficiency of a steam-power plant even if, as in this case, all the heat of chemical combination is put into it.

In degrading the heat from 5,000 to 700 deg. F., the possible thermal efficiency is immediately reduced by about one-half. Then come the losses in the engine and auxiliaries. Taking into account the losses in electrolysis and the heat of compression of the gases, the final over-all efficiency of the process suggested by Mr. Lagerquist would be about 20 per cent at the most.

Since the thermal efficiency of the first conversion would be, in a well-designed plant, about 25 per cent, then the final efficiency of that portion of the power supplied by the hydrogen-oxygen arrangement would be 20 per cent of 25 per cent, which equals 5 per cent from coal to busbar. It would be better to install another unit to take care of the peak.

Victoria, B. C., Canada. H. C. GUNSON.

Scientific Engine Selection

I have read with much interest the timely editorial in the July 28 issue on "Scientific Engine Selection." There is no doubt that many misapplications of steam engines are made. In fact, the whole field among the industrial and commercial building offers excellent opportunities for study in the selection of steam prime movers, whether it be engines, turbines, refrigerating machines, pumps or air compressors.

In the non-condensing field of steam application there are thousands of dollars wasted annually by making the wrong selection of steam-driven apparatus and in scores of other cases many misapplications are made by driving apparatus with electric motors where steam-driven machines would do the job with much less fuel at the boiler furnaces.

The installation of motor-driven air compressors and refrigeration machines is, in the writer's opinion, examples of the fallacy of the inefficient use of the motor drive in situations where steam boilers necessarily have to be maintained under pressure at all times.

A motor-driven air compressor under conditions of delivering a variable quantity of air (which most air services are) is a very extravagant piece of apparatus in power consumption even with so-called automatic control.

There are many erroneous notions about the efficiency of the electric motor drive. Because the electric drive is highly efficient in many applications of power, there has been a strong tendency on the part of the power user to put motors on almost everything without even questioning the efficiency of the application as a whole. In a situation where steam is available at suitable pressures, a steam-driven air compressor will show much better economy than the motor-driven one when measured at the boiler. It has been more or less of a mystery to me why so many motor-driven compressors have been installed.

The efficiencies of the two drives stand in comparison about as follows. The relative amounts of power at the steam cylinder of the engine driving the generator to make the current for the motor and in the cylinder of the steam-driven compressor are shown in the following table:

	Motor-driven air compressor per cent	Steam-driven air compressor per cent
Indicated horsepower at steam cylinder	100	100
Steam-engine efficiency	94	...
Generator efficiency	90	...
Transmission efficiency	98	...
Motor efficiency	85	...
Compressor efficiency	85	85
Net indicated power at air cylinder.	59.9	85

The two drives, it will be noted, stand in comparison about as 60 is to 85. Or in other words, one horsepower in the engine cylinder driving the generator would deliver at the air end of the motor-driven compressor not more than 6/10 of a horsepower, while one horsepower in the steam cylinder of a steam-driven compressor would deliver 85/100 of a horsepower at the air end of the compressor.

Getting back to the selection of engines, it frequently happens that because all the exhaust steam can be used at times, the argument is advanced that engine economy makes no difference. The fact, that at other times there may be a surplus of exhaust (which is often the case) is not considered. If all the exhaust steam from an engine is used all the time, this makes the most efficient combination. And if this exhaust is not sufficient to make up the low-pressure needs, it should come from the boilers directly through a reducing valve or from other steam auxiliaries that might be in use when the additional low-pressure demands are greatest. Examples of such might come from indirect hot-blast fans driven with engines instead of, as is often done, with motors, or steam-driven vacuum pumps rather than motor-driven ones.

Again, many plants have prolonged periods of light loads during the season of the year when there might be a surplus of exhaust steam. Under these conditions an engine, with as flat a steam curve as possible, is desirable. This is when the unaflow engine gets in its good work because its steam-economy curve is flatter than the efficiency curve of a modern electric generator.

Many people believe that the steam turbine is inherently a more economical machine than the reciprocating steam engine. But they do not take into account that the turbine is inherently a condensing machine, if it is going to be economical in the use of steam. The turbine does its best work from atmospheric pressure down to the lowest obtainable vacuum, whereas, the reciprocating engine does its best work from initial pressure down to atmosphere.

There have been and still are many misapplications of turbines made for non-condensing services when reciprocating engines would do the same work on easily 50 per cent less steam.

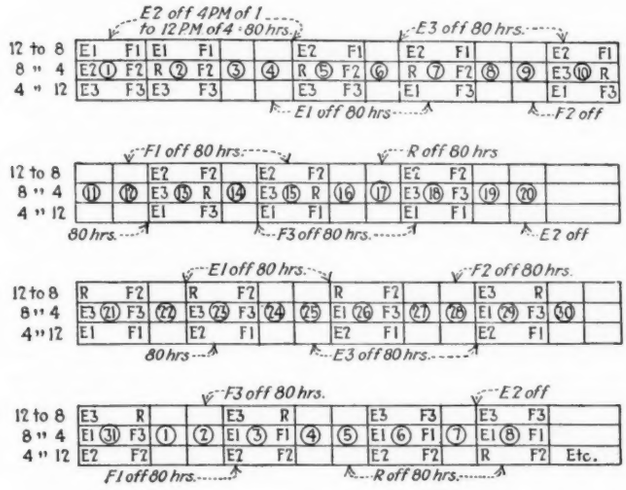
Selecting of engines and choosing of motors is too often left in the hands of those who have the devices for sale. And often too much is based on pure guesswork as to the quantities of power and steam required.

Milwaukee, Wis. EGBERT DOUGLAS.

How Often Should Engineers Change Shifts?

"Referring to the letter of R. G. Summers in the May 19 issue on "How Often Should Engineers Change Shift?" I should like to add to the comments that have already appeared on this subject. In my opinion it is decidedly not a good idea to leave the watch engineers and firemen on the same shift continuously. Any man working, say, the 12 to 8 a.m. shift continuously is not living the natural cycle of life and the home life of such a man cannot be the same as that of most people. Any shifts "off" only tend to accentuate the undesirableness of such arrangement, and unless a man is extraordinarily philosophical, the adverse effects of prolonged night work will show in his general health, work and ambition, even though he may be unaware of it himself.

Furthermore, the best of watch engineers need supervision at times, which they rarely get in average



Shift schedule arranged for eighteen shifts on and eighty hours off

power-plant night work. If, owing to extraordinary circumstances, it is necessary that a man be kept on evening or night shift continuously, I would insure that he receive extra compensation, either in pay, shorter hours or time off, and occasional direct supervision and encouragement.

The changing around of shifts, in addition to social and domestic opportunities conferred, not only varies the monotony of life, but gives each man the opportunity for some sleep at the natural time and also gives him a chance to become better acquainted with the working of the plant. Most plants have considerable variations in the work throughout the day and week and experiencing these will tend to keep the men interested and more useful to the plant.

Where feasible, I consider it a good plan to arrange shifts so that engineers and firemen will not have the same shiftmates continuously. In an eight-hour-shift plant this can be done by having the engineers move forward one shift and the firemen move backward one shift each change of shifts or have shift changes for each on different weeks. Such arrangement tends to cut out "cliques," promotes standard operation and a general desire to work in harmony with all the staff.

Duration between shift changes is a matter which considerably affects personal well being and harmony among operators. It is generally conceded that the less often one has to change over to night shift the better. Every time the night shift comes round, the endeavor to adjust oneself to the unnatural conditions means a temporary depression and loss of sleep. Where there is no relief man, we must also consider the matter of doubling up, in order to effect the change. In an eight-hour-shift plant, it is preferable to have the relieving shift work two eight-hour shifts within the twenty-four, rather than have two relieving shifts work twelve hours each.

For a plant operating on 3 shifts, 24 hours a day, the year round, with a six-day week allowed, the schedule here shown is a good workable example. This is one I instituted in the plant I am now in charge of, and it has satisfied everybody so far.

Its advantages are: Changes are not too frequent, thus giving the men a chance to get settled on each shift; there is no doubling up; the relief engineer-fireman takes his turn equally with the rest at all shifts and takes the same time off, hence there is no feeling among the men over holidays and Sundays off. In the case of sickness, etc., the relief man is available for replacing either engineer or fireman.

In the schedule shown, E1, E2, E3 are watch engineers, F1, F2, F3 are firemen and R is the relief, who works nine consecutive shifts as engineer, plus nine as fireman and then takes 80 hours off. It will be noticed that each man works eighteen consecutive shifts, takes 80 hours off and then moves backward one shift. This arrangement works equally well with twelve shifts on and 56 hours off.

Whether, as Mr. Summers queries, the men or the chief arranges the shift schedule, is immaterial; the important thing is for the chief to see that the chosen schedule is faithfully and consistently adhered to, after first assuring himself that it is the best for all concerned. I have always secured harmony in this, and other things, by first explaining the related operating facts to each man, getting his own preference, and then making a schedule to suit the majority. Most of them leave it to the chief, anyhow.

St. Paul, Minn. W. SPOFFORTH.

An arrangement of shifts that has worked out satisfactorily and that appears to be well liked by the turbine engineers and underground pumpmen at our mine is as follows:

A shift — 7 a.m. to 3 p.m.
B shift — 3 p.m. to 11 p.m.
C shift — 11 p.m. to 7 a.m.

Six shifts are worked on this schedule, and when a change is made on Sunday morning, B goes on duty at 7 a.m. to 11 p.m. (16 hours), A goes on duty at 11 p.m. to 7 a.m. (Monday morning), C goes on shift B after being off duty for thirty-two hours. This gives all men working on this schedule thirty-two hours off every three weeks.

Our hoisting engineers and firemen work on the same schedule except on Sunday. A takes C shift on Sunday night, B takes A shift and C takes B shift. This plan is not looked upon as favorable as the first schedule because it does not give any Sunday off.

Norway, Mich. THOMAS PASCOE.

Questions and Answers

Conducted by

Franklin Van Winkle

Excessive Compression in One End of Corliss Engine Cylinder

Without applying an indicator how can it be known whether a single-eccentric Corliss engine has too much compression on one end? *S. P.*

In any case the compression should be sufficient for smooth running of the engine, but not so much as to force a steam valve off its seat. When there is excessive compression, there will be noise from rattling of the steam valve on the end of the cylinder in which the exhaust stroke is nearing completion. Less compression would be obtained by shortening the exhaust-valve rod of the same end.

Depth of Back Connection for R. T. Boiler

What should be the distance from the rear tube sheet of a return-tubular boiler to the rear walls of the setting? *W. F. A.*

The rear wall of a return-tubular boiler setting should be far enough behind the tube sheet to permit space for a person to examine or to reroll the tube ends. For that purpose it should be not less than 24 in. For boilers 72 in. in diameter or larger, the space should be not less than 32 in. Even more space is beneficial for equalizing the distribution of the heated gases to the tubes. However, the larger the space the greater the difficulty in maintaining the arch or other roof material of the back connection.

Projected Area of Rivet

What is meant by the projected area of a rivet? *W. P. S.*

The projected area of any object is the area of outline of the projection such as shown by projections or views of ordinary mechanical drawings of objects, which are known as "orthographic" projections. An orthographic projection giving the side view of a piece of shafting would show the length and diameter. The figure would be a rectangle and the projected area would be the area of the rectangle, that is, the length multiplied by the diameter. The projected area of that part of a rivet which takes the bearing of a plate is the diameter of the rivet multiplied by the thickness of the plate.

Finding Amount of Piston-Travel Clearance

How can it be determined how much piston-travel clearance an engine has at each end of the stroke? *T. P. R.*

Make a mark on the crosshead and a corresponding mark on one of the guides when the crank is on one dead center and then on the other. After these marks are located, detach the connecting rod from the crosshead or the crankpin. To test the piston clearance at the head end of the stroke, move the crosshead as far as it will go when the piston is pressed hard against the head of the cylinder and make a new mark on the guide to correspond with the mark previously made on the crosshead. The distance between this mark and the mark previously made on the guide with the connecting rod in place will be the piston-travel clearance in the head end. In the same way find the piston-travel clearance in the crank end by moving the crosshead as far as it will go with the piston pressed hard against the crank end of the cylinder.

Effect of Lift and Area of Pump Valves

What effect have the lift and area of valves on the speed of a direct steam pump when pumping water or other liquids? *J. A. F.*

The lift must be sufficient to allow as much water to pass under the valve as discharged through the free area of the valve seat, and no matter how much the lift or the free area of the valve seat, there is some loss of pressure required for overcoming the friction of flow. For a given rate of discharge less lift of the valve, or a reduction of the free valve area, requires greater velocity of the liquid through the valve, and there is greater loss of pressure, requiring higher pressure of steam for operating the pump at a given speed with the same suction and discharge pressures.

Capacity of Air Compressor

What number of cubic feet of free air are compressed to 100 lb. gage per minute by a 13x24-in. single-stage compressor running 90 r.p.m.? *M. G. R.*

The quantity depends on cylinder clearance volume, valve and piston leakage and temperatures. In the beginning of a suction stroke the cylinder clearance spaces on the suction side of the piston are filled with compressed air at receiver pressure, and before free air can be admitted, the piston must proceed on the suction stroke far enough for the compressed air in the clearance space to expand down to the suction pressure.

From this cause the volume of free air admitted is 5 to 10 per cent less than the volume of piston displacement, the amount depending on the percentage of cylinder clearance volume. This, together with leakage of the piston and of the discharge valve, and expansion of the intake air to greater volume from coming in contact with the warm cylinder walls, makes the volume of free air that is receivable at atmospheric temperature only 80 to 85 per cent of the volume displaced by the piston. The piston displacement of a 13x24-in. compressor would be $13 \times 13 \times 0.7854 \times 24 \div 1{,}728 = 1.84$ cu.ft. per stroke, and allowing 82 per cent volumetric efficiency would make 82 per cent of $1.84 = 1.5$ cu.ft. per stroke, and for a double-acting compressor running 90 r.p.m. with the assumed efficiency there would be compression of $2 \times 1.5 \times 90 = 270$ cu.ft. of free air per minute.

Failure of Firedoor Arches

We are troubled with burning out of the firedoor arches of the setting of a return-tubular boiler. How can this be remedied? *W. B. G.*

Crumbling of the front wall and failure of the arches undoubtedly result from the passage of the highly heated furnace gases through cracks in the front wall of the setting direct to the smoke uptake, which of course is also detrimental to full economy. The condition is likely to arise when the brickwork has not been thoroughly bonded and grouted, or where a flow of heated gases direct to the uptake is induced by imperfect sealing-off of the heated gases where the front wall laps under the front end of the boiler. The best provision against failure of the arch and wall is to employ single-span firebrick arch blocks. If these are not obtainable, the front wall should be corbelled above the firedoor arches if that is necessary to obtain sufficient thickness for not less than three inches lap under the end of the boiler to obtain better protection of the sealing employed for the joint in the bottom of the front connection.

Removal of Oil from Leather Belting

How can oil be removed from leather belting without injury to the strength of the leather? *R. R. K.*

Any solvent of the oil, such as gasoline or an alkaline wash, is likely to impair the natural cementing substance of the leather more than the presence of the oil itself. A considerable proportion of the oil can be removed by scraping and rubbing the surfaces of the belt clean with a cloth. When running leather belts are likely to become saturated with oil, much of the oil can be removed by fixing a stationary scraper, made of thin spring steel, and extending clear across the lowest part of the belt for wiping off the oil. Another way is to remove the belt from the pulleys, wipe it as dry as possible, place it on edge in an open coil and leave the spaces between coils filled for a few days with clean, fine sawdust, pulverized chalk, whiting, carbonate of magnesia or fullers earth for absorbing the oil by capillary action. Still another way is to squeeze out the oil by passing the belt slowly between a pair of vertical pressure rolls.

Aligning Centrifugal Pump with Engine

We have a centrifugal pump to be driven by an oil engine. What is the simplest way of aligning the pump pulley with that of the engine so the belt will not run off? *A. C. T.*

With perfect-running crown-faced pulleys and a pliable belt of uniform thickness, width and strength the shaft of the centrifugal should be parallel with the engine shaft. As perfection of belt and pulleys is not to be expected, and without knowing in advance what deficiencies are to be compensated, the centrifugal should first be set with its shaft level and parallel with the engine shaft, and there should be leeway in the setting of the engine or of the centrifugal for moving either on its foundation to compensate the imperfections by throwing the shafts out of parallel.

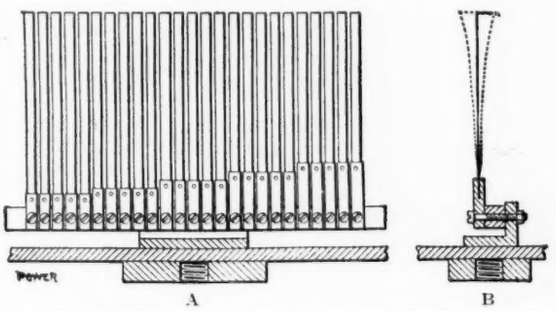
Assuming that the engine is on a foundation in fixed or central position, and the engine shaft is level, stretch a strong fine line over the engine shaft and have the line level and plumb over the centers at the ends of the shaft. Then fix a level line plumb over the place for the center line of the centrifugal shaft and have it parallel with the line over the engine-shaft center line, preferably by measuring the same distance from line to line with a rod and by taking measurements as far apart as practicable. The points for the ends of the center line over the centrifugal should, if possible, be permanent marks for future reference. Then the centrifugal should be set with its shaft level, with the middle of the pulley in line with the middle of the engine pulley and the center marks in the ends of its shaft plumb under the parallel line, or on the same side and at the same distance from lines of plumb bobs hung from the parallel line.

In this position there should be leeway in the fastenings and connections for moving the centrifugal around the pulley in either direction to throw the shaft out of parallel, if found necessary. When the centrifugal is anchored and the suction temporarily connected, prime the pump and make a trial run of the belt. If, when standing behind the engine and looking toward the centrifugal, the belt runs off the centrifugal pulley to the right, then the centrifugal or the engine is to be moved so the end of its shaft which is on the right will be farther away from the engine; or if the belt runs off to the left, so the end of the shaft which is on the left will be farther away from the engine.

Vibration Tachometer

What is the principle of construction and operation of a vibration tachometer? *R. T.*

The vibration tachometer is an application of the principle of resonance, in which one or more rows of tuned reeds are mounted side by side on a common



Reed mounting of vibration tachometer

base as shown at *A* in the figure. The reeds are made of thin spring steel about ½ in. wide with their upper ends bent over, as indicated by the full line in the cross-sectional elevation *B*. The instrument is firmly mounted or connected with the frame of a machine for indicating the r.p.m. of a principal revolving element, as the rotor of a turbine or centrifugal pump, which is never perfectly balanced. The number of principal vibrations is the same as the speed of rotation, and that reed in the instrument which is most nearly in tune with the number of revolutions vibrates with greatest swing, back and forth, as indicated by the dotted lines. Fig. B. The interval between the reeds usually is 1 to 2 per cent of the maximum range that is to be indicated. A graduated scale placed near the free ends of the reeds gives the number of revolutions per minute, and that value is taken which corresponds with the reed that shows the greatest amplitude of vibration. Should the reeds vibrate excessively, their motion can be dampened by placing a piece of felt between the machine and the supporting bracket.

Shaft Whipping Due to Oil Action in Journal Bearings*

By Dr. B. L. Newkirk and H. D. Taylor

THE authors who have previously shown one type of shaft whipping to be supported by the cramping action of long sleeves or hubs on shafts running above critical speed, report in this article their investigation of the action of the oil pressure developed in journal bearings in supporting shaft whipping.

Fig. 1 shows a typical arrangement of the models tested. A pointer was attached at one end of the shaft, so that vibration or whirling could be observed in strong light with a low-power microscope.

Figs. 2 and 3 indicate in a descriptive way the behavior of a model. The critical speed vibrations are shown at about 800 r.p.m. A much larger peak of vibration was found at 1,520 r.p.m., a little less than double the critical speed. Whipping started at 2,250 r.p.m., growing more violent with further increase of speed.

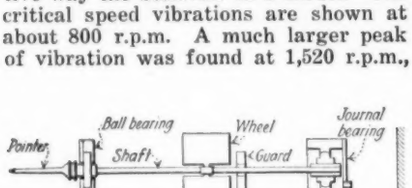


Fig. 1—Typical arrangement of models

Cause of Whipping

The wheel fit was so tight that the whipping could hardly be due to "working" of the fit. Three other factors were tested and eliminated: (1) the belt drive; (2) the degree of unbalance; and (3) the thrust-collars on the shaft.

The first positive indication of the cause was that whipping was stopped immediately by shutting off the oil supply to the bearings and could be brought back to full amplitude promptly by turning the oil on again. The use of one friction-damped spring bearing was found also to stop the whipping.

By the use of self-aligning bearings, it was found that misalignment prevented whipping, but that when ball-seated bearings were permitted to align themselves, the models whipped quite as violently as when running in sleeve bearings.

These results indicated that some action of the oil in the journal bearings was responsible for the whipping, and in consequence the authors have called it the "Oil Whip," to distinguish it from whipping due to cramping fits.

Theory of Oil Action

The pumping action of a rotating journal causes it to take an eccentric position in the bearing. It is easy to believe that this pumping action is not perfectly steady. Further, the average velocity of the oil is about half that of the journal surface, since the oil is in contact with the moving surface on one side and with the stationary bearing surface on the other. Hence, such impulses as are developed, it seems reasonable to assume, will appear with a frequency equal to half the shaft speed. In order that these half-speed impulses may be in resonance with the critical speed of the shaft, the actual speed must be double the critical. This seems to check the initial appearance of whipping at double critical speed, which the authors call the oil resonance speed. As the speed is increased still further, one might expect the frequency of the oil action to increase, the resonance to be lost and the shaft to run quietly at all higher speeds. This actually occurred with one model set vertically with the bearing cap loose, but with the model horizontal the shaft failed to "pull through" the oil resonance. The reason seems to be that the oil action is reduced in frequency when it meets with frictional resistance, so that it maintains the vibration even though the rotational speed is raised above that corresponding to the oil-resonance speed.

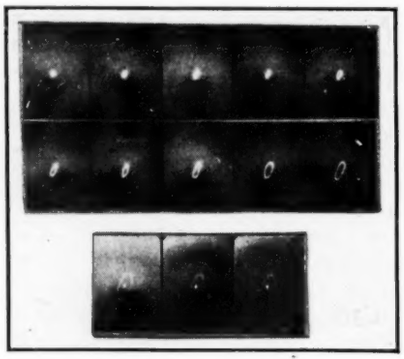


Fig. 2—Moving picture record of shaft whipping

Top: Building up of whip in well-balanced rotor. Bottom: Double exposure—whip centers on steady position.

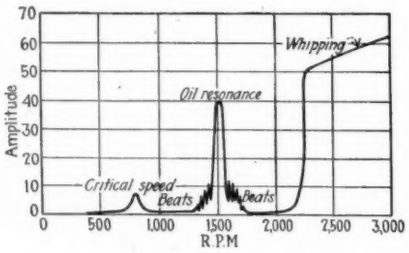


Fig. 3—Vibration at critical and oil-resonance speeds, with whipping at higher speeds

How to Stop Whipping

Tests were undertaken to study the effect of bearing length, type of oil grooves, bearing clearance and bearing load upon whipping. The performance of bearings 1 in. in diameter, of various lengths and with various clearances, is shown by the curves of Fig. 4, which indicate that short bearings with large clearance have the least tendency to produce whipping.

Tests with various types of oil grooves indicated that, while some arrangements are more favorable than others, no complete remedy is to be found in this direction.

One model was used to study the effect of bearing load. Additional wheels were shrunk on the shaft. The results indicate that the oil whip may be avoided by the use of high bearing pressures.

Shaft whipping from this cause may be prevented in six ways: (1) By shutting off the oil supply to the bearings; (2) by misalignment of bearings; (3) by steadying the shaft; (4) by confining operation to a speed range below twice critical speed; (5) by the use of a friction-damped bearing; and (6) by avoiding very light bearing loading pressures. Of these remedies (1) and (2) are obviously impracticable for commercial application and (3) involves making contact with the shaft, which also is undesirable. The other three are practical means to avoid the difficulty.

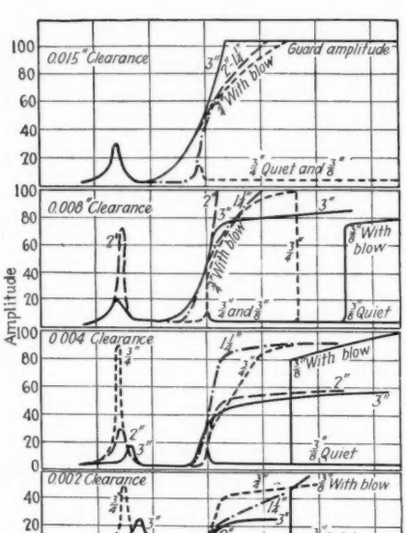


Fig. 4—Vibration and whipping with bearings of various lengths and clearances

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River Power—The City of Los Angeles has applied to the Federal Power Commission for a preliminary permit covering a project on the Colorado River in San Bernadino County, Colo., and Yuma and Mohave Counties, Ariz. The project is in the vicinity of Parker, Ariz., and Needles, Colo. The plan provides for the storage of some 600,000 acre-feet in a reservoir near Parker, where a head of ninety feet can be obtained. The amount of primary power that will be made available is estimated at 108,000 hp.

*Abstract of article in the *General Electric Review* for August, 1925.

Iron and Steel Electrical Engineers Hold Annual Convention

Accident prevention; selection and maintenance of oil circuit breakers; direct-current armature windings for multipolor generators and motors; auxiliaries and auxiliary drive for steam plants; and extending the heat cycle in boiler operation were among the subjects discussed.

DISCUSSION of the safety problems in steel mills as they affect the work of the electrical engineer was one of the outstanding features of the twentieth annual convention of the Association of Iron and Steel Electrical Engineers held in Philadelphia Sept. 14 to 19, 1925. Convention headquarters were at the Benjamin Franklin Hotel. In conjunction with the convention the Association's Iron and Steel Exposition was held in the Philadelphia Commercial Museum, at which place the four technical sessions were also held. Over 100 firms exhibited electrical and mechanical equipment as applied to steel mills, and 500 members and guests registered for the convention. Among the important social functions were the informal dance on Monday evening and the dinner dance on Thursday evening.

Election of Officers

The officers elected were: President, G. H. Schaeffer, elec. eng., Carpenter Steel Co., Reading, Pa.; first vice-president, S. S. Wales, chief elec, eng., Carnegie Steel Co., Pittsburgh, Pa.; second vice-president, A. J. Standing, elec. supt., Saucon Plant, Bethlehem Steel Co., Bethlehem, Pa.; secretary, F. W. Cramer, elec. eng., Bethlehem Steel Co., Johnstown, Pa.; treasurer, James Farrington, elec. supt., Wheeling Steel Corp., Steubenville, Ohio.

It has been decided to hold the next annual convention in Chicago some time during June, 1926. This change from September to June in the convention date was decided upon so as to conflict as little as possible with other conventions in which the members of the association may be interested.

In the association there has recently been formed a safety division to coordinate the efforts of the electrical engineers and safety directors in the steel industry in order that all electrical equipment may be so protected and personnel so trained as to safeguard employees whose duties subject them to possible hazard from this source. The progress made in the electrification of steel mills has been such as would indicate that the whole industry will be practically electrified in ten years, and for this reason it has been deemed advisable to expand the association's activities in safety work.

Monday Afternoon Session

The opening session of the convention which followed a Monday noon luncheon at the Benjamin Franklin Hotel was devoted to the presentation and discussion of a number of papers on safety. President A. C. Cummins presided and outlined the purpose of the new division. This new division will not conflict with the activities of the National Safety Council because it is the purpose to limit the work to the solution of the problems that continually face the members of the association in a highly specialized field of industrial safety. The steel industry's co-operation in this movement has been assured, said Mr. Cummins, and each and every member's co-operation is solicited to make the new division a success.

Safety in the Steel Industry

L. H. Burnett emphasized the vast change that has come about in the attitude of those in the steel industry regarding safety. Beginning as a side issue this movement has grown to where it is in the heart and mind of practically everyone in the industry. It used to be practically impossible to get a steel-mill operator to discuss safety practices; today it is one of the foremost things in their minds. The speaker was of the opinion that one of the great problems of electrical engineers in the steel industry was to teach safety to the men in their departments. The greatest thing that can be done for safety is to teach the man on the job to look out for himself and those associated with him. A good omen to Mr. Burnett for safety was the fact that one session of the convention was devoted to the subject.

The electrical engineer in the steel industry, said C. L. Baker, has done much to advance the safety movement and had a great deal to do with the founding of the National Safety Council. The day is practically past when you can walk into a steel plant and not find safety being given consideration. In the opinion of the speaker it is a matter now of educating all the men in the different departments of the plant to think safety, then there will be no accidents to themselves or their fellow workers.

John A. Oartel told how the electrical engineer and the safety engineer can be mutually helpful, and emphasized the necessity for co-operation between the safety and electrical engineers, by calling attention to serious accidents that have happened due to a lack of this co-operation. The safety engineer has been delving into the inner workings of human minds to find out the reasons for accidents just as the electrical engineer has been studying the electrical problems of the plant to determine the most efficient methods. The electrical engineer and the safety engineer have both had marked success in their professions, but the time has come for them to be co-workers, each helping the other by a closer co-operation and a better spirit to the achievement of a common aim—efficiency with safety.

The National Safety Council

Henry A. Renninger told of the growth of the National Safety Council from the 1912 convention of the Association of Iron and Steel Electrical Engineers, when a nucleus of safety leaders first conceived the idea of organizing a National Association to study national accident-prevention problems and establish a clearing house of information for safety in the workshop, on public highways and in our homes. The National Safety Council now includes in its membership 4,028 industries, railroads, associations, industrial boards, schools, colleges and other institutions (400 of the members reside in 22 foreign countries) representing 3,000 workshops and over 6,000,000 workers.

In speaking of preventing accidents among electrical workers, Mr. Renninger expressed the opinion that one of the big problems was with the low-voltage circuit, from 110 to 550 volts, as it had been his experience that on these voltages the greatest number of accidents occur.

C. B. Auell characterized the air brake for railway trains as the greatest safety device ever conceived and also the greatest civilizing influence. An accident that results in the loss of life may, said the speaker, retard civilization for many years, and he emphasized this statement by calling attention to the lost arts, some of which have never been found again.

W. S. Hall was of the opinion that close to 90 per cent of accidents are the fault of the workmen themselves. Large expenditures have been made for the prevention of accidents and still they occur. For this reason the speaker recommended that effort be concentrated on educating the workers in safety principles rather than on means of preventing accidents.

Selection and Use of Oil Circuit Breakers

Tuesday's technical session was devoted to a consideration of the problems involved in the selection and use of oil circuit breakers. Until quite recently this problem has not been a serious one in the steel-mill power plant. At this time there are many plants of such size or they are con-

nected in with central-station systems that can feed sufficient energy into a fault to make the switches used on the earlier steel mill power systems inadequate to disconnect the line or piece of equipment in trouble from the system. The two papers presented on the "Selection and Maintenance of Oil Circuits," one by George A. Burnham and the other by M. J. Wolgemuth and E. K. Read, went into the problems involved in interrupting a short-circuit on a large power system and the care necessary to give oil circuit breakers to have them perform the service for which they were designed.

Various Designs of Breakers Described

Mr. Burnham, after discussing the factors affecting the selection of oil circuit breakers showed a number of different designs of modern breakers, which use a double tank arrangement, that would relieve the pressure rise inside the oil tank during the interruption of a heavy current and at the same time prevent the oil from being thrown from the tank. The speaker emphasized the necessity of rigid structures for supporting the breaker and its operating mechanism and also for providing means to take care of exploding gases in the tank in a way that would prevent excessive pressure rises that might cause the tank to bulge or fracture the supporting frame. This paper will be published in abstract in an early issue.

Messrs. Wohlgemuth and Read called attention to the lack of attention given switching equipment in steel-mill power plants until recently, when the rapid developments in the industry have forced serious attention of this problem. In the paper a problem is worked out in detail showing how the proper size and type of equipment is selected. Great stress was laid on the importance of maintenance of oil circuit breakers by the authors, and they said that an alert operator can make himself very valuable in the preventing of outages by watching the apparatus with the idea of continuity of service in mind. An abstract of this paper will appear in an early issue.

In the discussion of these papers interest was centered on the possibilities of reducing the cost of oil circuit breakers. The size of steel-mill power plants had increased and in some cases had been connected in parallel with central stations, all of which made it necessary to use much heavier and more expensive switching equipment. The cost of switching equipment had under these conditions become a large item of expense in the electrifying of a mill, and anything that might be done to reduce this expense without sacrificing reliability would be welcomed by steel-mill electrical engineers.

It was brought out that a great deal of work had been done in Europe to reduce the duty imposed upon oil circuit breakers, but when the added expense of the schemes are considered in with the cost of the smaller breakers, there is not much saving in expense over the breaker that is designed to handle the circuit without the assistance of auxiliary equipment, such as introducing reactance in the circuit before the final interruption of the circuit is made.

The use of a master breaker offers one solution to the problem, but would interfere with the continuity of the system. A number of feeders are taken through the master breaker which has sufficient capacity to open any of the circuits under abnormal conditions. Each of the individual feeders is equipped with oil switches of sufficient capacity to open and close the circuit under normal operating conditions, but they do not open when there is trouble on the system—this is taken care of by the master breaker. The objection to this system is that in case of trouble on one feeder, all the circuits passing through the master switch are interrupted and might seriously interfere with the operation of the plant.

The use of oil circuit breakers versus high-voltage fuses was given attention. It was agreed that both had their place, but the fuse had the objection of having no selectivity as to the time required to open the circuit; as a result it was likely to open it when there was no necessity for doing so. Furthermore, when a fuse blows it is necessary to replace it with a new one, while the oil circuit breaker can be immediately reclosed.

Direct-Current Armature Windings

A paper attracting a great deal of attention was that by W. H. Powell and C. M. Albrecht (both of the Allis-Chalmers Manufacturing Co.) on "Direct Current Armature Windings for Multipolar Generators and Motors —Frogleg Windings." In this new type of winding a series of wave winding is superimposed on a parallel or lap winding. A coil for each of the windings, after being insulated, is grouped and taped together as one coil, so that although there are one side of two different wave coils in the same slot, along with one side of two different lap coils, making a total of four coil sides in the same slot. The winding from the back end of the armature is like the ordinary two-layer winding with two coil sides per slot. The two windings are so interconnected on the commutator that the wave winding, in addition to being a normal winding and producing one-half of the output of the machine, also serves as the equalizing connection for the lap winding, giving 10 per cent equalization.

A number of machines with this type of winding have been built and are reported to have shown superior operating characteristics over similar machines but with the conventional type of windings. A series of tests were made on a 3,000-hp. double-motor unit to observe its commutating characteristics under abnormal conditions. In these tests one half of the unit acted as a motor and the other as a generator. The unit was driven by a belt from another motor in order to furnish power for the losses. Each half of the double unit had 12 poles, and the full load rating of each armature was 4,800 amperes at 250 volts.

In one test the shunt coil on one pole was short-circuited and all the brushes on one brush-stud were lifted from the commutator. These brushes were four poles away from the pole with the short-circuited coil. The load was started at zero and gradually increased to 9,800 amperes and held at this value for 6 minutes when the driving motor and belt indicated they would stand no greater overload. Under this abnormal operating condition and with over 100 per cent overload there was no sign of sparking on the commutator.

Apparently, from the discussion on the paper, there is a wide diversity of opinion among designing engineers as to the advantages and disadvantages and also as to how some of the results were accomplished that were accredited to the new winding. Probably the most serious objection raised against the new winding was the added complications in the connections and the increased difficulties in making repairs, when compared with the conventional type of windings with equalizer connections. However, both windings are complicated and would require a lot of qualifying statements to make a fair comparison.

Thursday's technical session was devoted to a presentation and discussion of the Electric Heat Committee's Report.

The convention closed on Friday with a session on power generation. At this session two papers were presented, one by A. L. Penniman, Jr., and F. W. Quarles, on "Auxiliaries and Auxiliary Drives for Steam-Electric Generating Stations," and the other by J. G. Worker, on "Extending the Heat Cycle in Boiler Operation by the Use of Preheated Air for Combustion." Abstracts of these papers along with the discussion will appear in an early issue.

U.S.S. "Lexington" To Be Launched October 3

The second of the United States Navy's new airplane carriers, the U.S.S. "Lexington," will be launched at noon, Oct. 3, at the Fore River plant of the Bethelehem Shipbuilding Corp., in Quincy, Mass. As in the case of the "Saratoga," which is not yet in service, of which this boat will be a duplicate, the "Lexington" will be one of the largest ships ever launched on the western hemisphere and will excel the first-line battleships of this country in propulsion power.

The length of the "Lexington" will be 874 ft., its beam, 105 ft. and the output of its electric generating equipment will be 180,000 hp. The complete electrical equipment will be furnished by the G. E. Co. The propulsion apparatus will consist of four 35,200-kw. turbine generators, supplying current to eight 22,500-hp. motors. The turbines will be operated by steam from 16 oil-fired boilers. The motors will be connected in pairs to each of the four propeller shafts. The total energy delivered to each shaft will be 45,000 hp. or sufficient to turn the propeller blades at a rate of 317 r.p.m. and to propel the ship at the rate of 33 knots.

In addition to the propulsion machinery there will be six 750-kw., direct-current auxiliary turbine generators which will furnish current for all electrical purposes except main propulsion.

New Standby Steam Plant for Los Angeles

The Board of Water and Power Commissioners of Los Angeles has instructed Chief Engineer E. S. Scattergood of the Bureau of Power and Light to prepare plans and specifications for a steam plant. This plant is to be a standby station to insure against interruptions in service. No details as to the type of plant to be erected are available at the present time.

Mormon Flat Equipment Purchased

The Salt River Valley Water Users' Association of Phœnix, Ariz., has just purchased complete generating and distribution equipment consisting of an S. Morgan Smith Co., vertical waterwheel generator and Westinghouse transformers and switching equipment. The unit is to be installed in at the Association's Mormon Flat Irrigation project. This project was outlined in August 18 *Power*, page 266.

Midwestern Power Show Offers $100 for a Slogan

To arouse interest and to stimulate constructive thinking as to the advantages to be gained by attending the engineering exposition and power show to be held in Chicago Jan. 26 to 30, 1926, the Midwestern Engineering Exposition, Inc., George E. Pfisterer, 53 W. Jackson Boulevard, Chicago, Ill., is offering, during the month of October, the foregoing amount for the best slogan for the show. This is to be accompanied by an explanatory letter telling why the slogan should create the right sort of impression on the man interested in the mechanical and electrical industries. The award will be made by three impartial judges.

Quoddy Project Indorsed By Maine Voters

The $100,000,000 project for utilizing the high tides of the Bay of Fundy for the generation of about 700,000 hp. to supply power to the eastern section of the United States and Canada was indorsed by a substantial majority of the voters of Maine at a special election held on Sept. 14. The plan, which was conceived by Dexter P. Cooper, engineer connected with the building of the Keokuk dam and the Muscle Shoals development, consists of the formation of two large storage reservoirs, the upper pool to be formed by Passamaquoddy Bay from which the water will be released through turbines into the lower pool of Cobscook Bay. The project was described at length in *Power*, Aug. 25, page 309.

Civil Aviation Being Studied

The Department of Commerce and the American Engineering Council are making a study of civil aviation and are gathering data that will be of value for constructive legislation. The chairman of the committee on civil aviation is J. Walter Drake, assistant secretary of Commerce; the other members are Dr. W. F. Durand, president of the A.S.M.E., Prof. E. P. Warner, Massachusetts Institute of Technology, L. K. Bell, Washington, former traffic manager of air mail, and C. F. Ludington, Philadelphia, general aircraft operator.

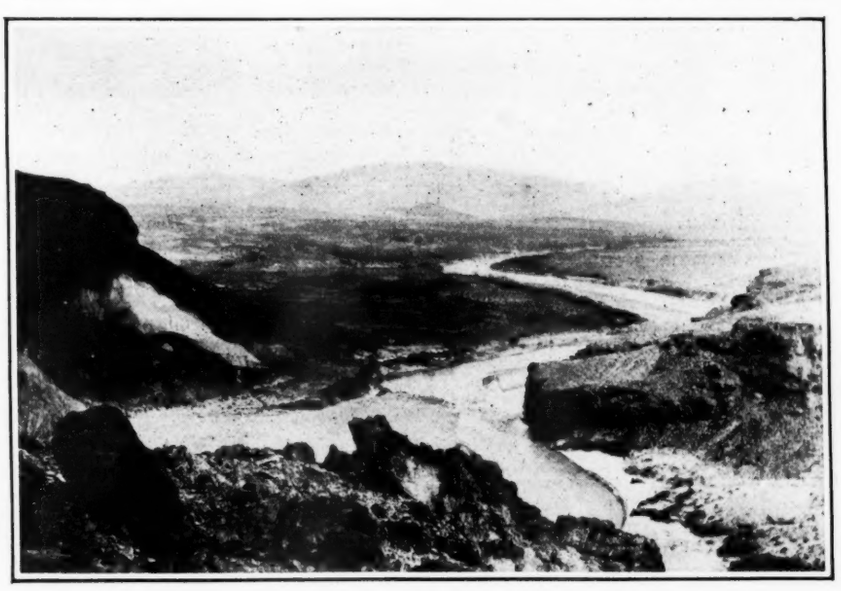
Colorado River Compact Endorsed by Three States

At the meeting of the representatives of the upper Colorado River basin states, held in Denver, Aug. 29, a declaration was prepared to the effect that the States of Utah, Wyoming and Colorado were in favor of adhering to the Colorado River Compact as now drawn up. These states were represented by their governors, state engineers and water commissioners. The meeting was for a purpose similar to the one held in Phœnix, Ariz., on Aug. 17, which was brought to an abrupt end by the ultimatum of Governor Hunt of Arizona. The Arizona representatives declined to commit themselves to an agreement stipulating the favoring of the construction of the Boulder Canyon project before consideration would be given to questions of allocation of water or power.

Charles A. Magrath To Succeed Sir Adam Beck

Charles A. Magrath, of Ottawa, former Dominion Fuel Controller and present chairman of the Canadian section of the International Joint Waterways Commission, has been appointed as chairman of the Ontario Hydro-electric Power Commission, made vacant by the recent death of Sir Adam Beck. Mr. Maguire, ex-Mayor of Toronto, has also been appointed to the commission. He is the nominee of the hydro-electric municipalities in Ontario.

In announcing these appointments, G. H. Ferguson stated that the hydro-electric project had now reached a turning point in its history. Its resources were within sight of being fully taxed. Beyond a possible increase of development at Niagara, and the power of the Ottawa River, the only opportunity for further development is in the waters of the St. Lawrence River. After careful consideration the Ontario Government had decided that Charles A. Magrath was the best man in Canada to replace Sir Adam Beck at the head of one of the greatest public ownership concerns in the world. As chairman of the Canadian Section of the International Joint Commission, which body has final jurisdiction over all questions involving the use of the boundary waters between Canada and the United States, Mr. Magrath had displayed a fairness and a judicial temperament which had won the confidence of his colleagues in the Canadian and American sections, and of all who have come in contact with the commission.



Boulder Canyon Reservoir site

Shannon Power Scheme Gets A Setback

According to press reports a labor dispute has caused the suspension of work on the Shannon water-power scheme, the contract for which was announced in the Sept. 15 issue of *Power*. According to this report the contract estimates were said to be based on the German wage hour rates which are about half that paid in the nearby Limerick district of the Irish Free State.

Baltimore To Have New Steam Plant

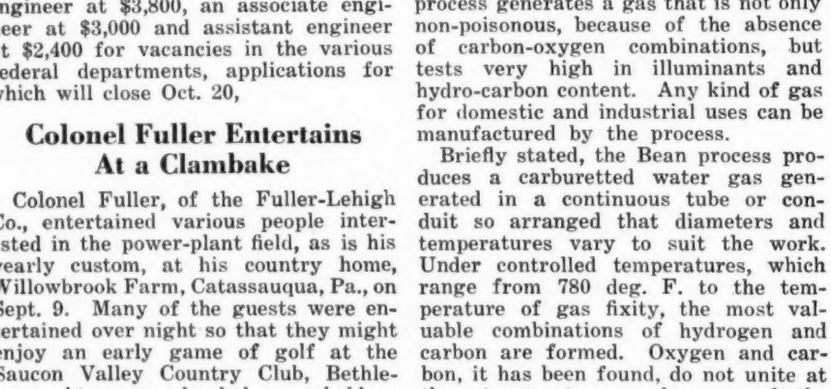
In order to keep pace with the demand for power at Baltimore, the Consolidated Gas, Electric Light & Power Co. has started to build the steam generating plant planned some time age for the company's water-front property at Gou'd and McComas Sts. The new station will begin generating a year from now and will be designed for four 36,000-kw. turbo-generators. Only one of these units, however, is to be included in the original installation.

U. S. Needs Engineer Employees

The United States Civil Service Commission announces open competitive examinations for an assistant mechanical engineer to fill a vacancy in the supervising architect's office, Treasury Dept., Washington, D.C. with entrance salary of $2,400 for which applications will close on Oct. 10 and also for an engineer at $3,800, an associate engineer at $3,000 and assistant engineer at $2,400 for vacancies in the various federal departments, applications for which will close Oct. 20,

Colonel Fuller Entertains At a Clambake

Colonel Fuller, of the Fuller-Lehigh Co., entertained various people interested in the power-plant field, as is his yearly custom, at his country home, Willowbrook Farm, Catassauqua, Pa., on Sept. 9. Many of the guests were entertained over night so that they might enjoy an early game of golf at the Saucon Valley Country Club, Bethlehem. At noon a clambake was held on the farm where everyone enjoyed the clams, as can be seen by the accompanying photograph.



Guests enjoying Col. Fuller's clams

G. E. Investigation Making Progress

The investigation of the General Electric Co. by the Federal Trade Commission only now is getting under full headway. Since the beginning of the fiscal year when the completion of other investigations released personnel for this work, the vacation season has been in progress. This not only has depleted the Commission's staff, but has taken representatives of the electrical industry out of their offices to such an extent that the field work has been conducted with difficulty.

New Process for Gas Manufacture Announced

Announcement of the development of a new process for manufacturing non-poisonous heating and illuminating gas from sludge and refinery residuums has been made by the Gas Bond & Share Corp. of America, through its president, Col. E. E. Garrison.

The process is the invention of Orestes U. Bean, inventor of the Bunsen furnace. It has been developed by Colonel Garrison and a group of well-known petroleum technologists including George B. Gifford, former chief engineer of the Standard Oil Co., and Vincent G. Shinkle, designer and operator of many of the largest existing compression gasoline extraction plants.

According to the engineers who have studied it, among whom is Alexander B. Way, former chief engineer of the Boston Consolidated Gas Co., the Bean process generates a gas that is not only non-poisonous, because of the absence of carbon-oxygen combinations, but tests very high in illuminants and hydro-carbon content. Any kind of gas for domestic and industrial uses can be manufactured by the process.

Briefly stated, the Bean process produces a carburetted water gas generated in a continuous tube or conduit so arranged that diameters and temperatures vary to suit the work. Under controlled temperatures, which range from 780 deg. F. to the temperature of gas fixity, the most valuable combinations of hydrogen and carbon are formed. Oxygen and carbon, it has been found, do not unite at these temperatures, and as a result the gas runs as high as 56 per cent illuminants in which there is a heat value of 2,230 B.t.u. per cu.ft., and 32 per cent methane with a heat of 1,009 B.t.u. per cu.ft.

The operation embraces no new or unrecognized chemical or physical principles. Its novelty consists in the assembly of all important reactions between the carbon of the oil and the dissociated hydrogen or superheated steam in a practical, almost automatic apparatus so constructed as to permit their full functioning.

Cleveland Will Vote on Additions to Power Plant

Despite adverse recommendations made by a Cleveland citizens' advisory committee headed by former Congressman Paul Howland and composed of representatives of various civic and business organizations, the Cleveland City Council has approved a bond issue for $500,000 for additions to the Cleveland municipal light plant, mainly in the Brooklyn station. This proposed bond issue, with various other issues, will be submitted to the voters of the city on November 3.

Calumet Power Co. Buys Generators

The equipment for the new station of the Calumet Power Co., at Michigan City, Ind., has recently been contracted for. It includes two Westinghouse 31.250-kva. turbine generators and two 32,000-sq.ft. radial-flow surface condensers with condensate pumps and air ejectors. A feature that makes the units differ somewhat from the ordinary type is the 600-lb. throttle pressure and the 750-deg. total steam temperature at which the turbines operate. Attached to the same shaft of each main generator is an auxiliary generator of 2,140 kva. rating at 2,300 volts, used to supply power for the station auxiliaries. There are also two direct-connected exciters on the same shaft, one for the main generator and one for the auxiliary generator.

Broad River Parr Shoal's Plant Started

Operation has been started at the new central steam-power station built on the Broad River at Parr Shoals, S. C., by the Broad River Power Co., a subsidiary of the General Gas & Electric Co. The first unit the construction of which was started last November, has been completed at a cost of $3,000,000. It has a capacity of 17,000 hp., with an extensive system of high-transmission lines. The plant, which has been designed for an ultimate capacity of 85,000 hp., will furnish electricity in Columbia and Spartanburg and throughout Central South Carolina.

The company also has several other plants in the district located at Columbia. Spartanburg and Gaffney, with a combined capacity of 35,000 hp. and these plants will be linked together with the new Parr Shoals plant by a high-tension transmission line. Powdered fuel is being used at these new plants. The results, according to the company, have been highly satisfactory, especially in economy.

Engineers' Societies Making Smoke Abatement Campaign

Realizing the need for closer and more effective co-operation between the engineer and the government in regard to smoke abatement, the Fuels Division of the A.S.M.E. co-operating with the American Society of Heating and Ventilating Engineers, The Stokers Manufacturers Association and the American Civic Society, is carrying on a vigorous campaign to arouse the interest of the mechanical engineers for service to the city, state and nation. H. W. Brooks, secretary of the Fuels Division of the A.S.M.E., is active in the movement and has sent out letters containing a bibliography of the literature on the subject. He quotes Prof. S. W. Parr, of the University of Illinois, who in writing an introduction to a recent treatise on fuels, has the following to say:

"The accentuation of the smoke evil in large industrial centers has set in motion numerous investigational activities looking to the abatement. Sooner or later these studies lead back, for a solution, to the carbonization of coal and the supplying of smokeless fuel in some form."

Shoals Generators Working Without Hitch

The Wilson dam since Sept. 12 has been contributing to the relief of the power shortage in the Southeast, where elevator service and lighting, along with many larger uses of power, are being curtailed. On that date the first power from the great government dam entered in to distribution. The No. 2 unit, after nearly two weeks of drying, was put on full load. It was found that 20,000 kw. would be generated with the head available. As this is written, the generator has continued in operation without the slightest hitch. Gen. Harry Taylor, the Chief of Engineers, and various experienced electrical operating men who were present, are outspoken in their praise of the performance of the unit.

With the 20,000 kw. furnished by this generator and the 65,000 kw. furnished by the steam plant, all transmission-line capacity away from Muscle Shoals is in use. It will be necessary to continue to operate the steam plant in excess of its capacity for another month, when it is expected the work on the permanent switchboard will have progressed to the point where two or more of the generators can be hooked up in parallel and an opportunity given to reduce somewhat the strain on the steam equipment.

Unit No. 1 is now drying. By the time this appears in print, Unit No. 4 will have been started. Unit No. 3 will have been turned over before the end of the month. These four units are of Westinghouse manufacture. The four G. E. units are being assembled rapidly.

The Department of Commerce announces that there were sold during the month of August, 91 mechanical stokers, installed under 27 38,800-sq.ft. fire-tube boilers and 64 259,850-sq.ft. water-tube boilers.

Shipping Board to Test Pulverized Coal

The Shipping Board, in conjunction with Naval officials, is preparing to conduct a series of tests on the burning of pulverized coal under marine boilers. Five hundred tons of pulverized coal has been ordered for these tests, which are to be run at the League Island Navy Yard in Philadelphia.

Motor Runs for Thirty-two Years

After more than 30 years of operation, the first polyphase induction motor to be placed in commercial operation on a central-station line in this country has been retired from active service and will be used by the General Electric Co. as an historical exhibit. This company recently completed arrangements with the Page Belting Co., of Concord, N. H., for the return of the old motor to Schenectady. The motor had been driving a group of machines through line shafting in the Page Belting Co.'s plant.

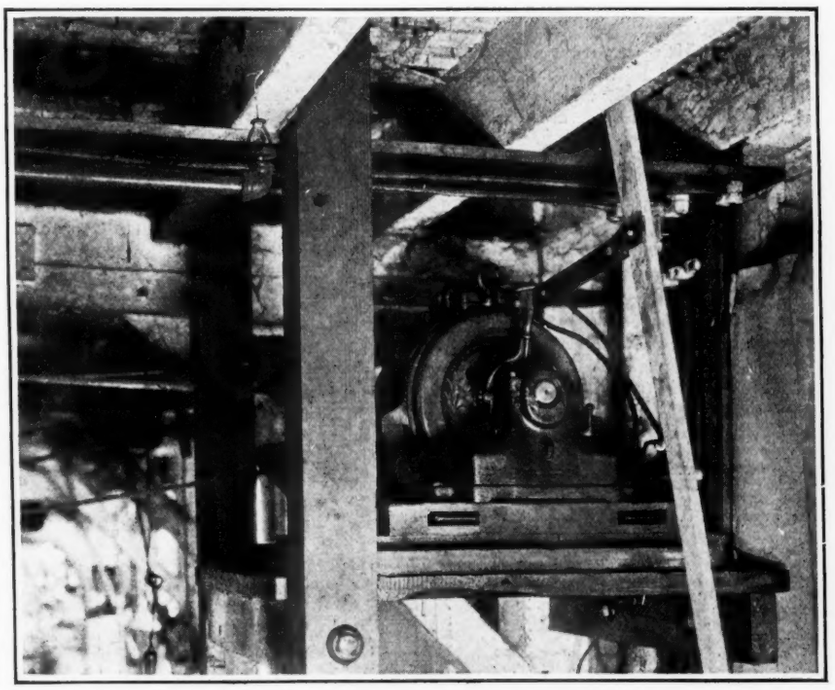
This motor was the first sold of the G. E. Type "TI" line first marketed in 1893. It was rated 5 hp., 1,500 r.p.m., 110 volts, 50 cycles, 3 phase, four poles and was originally sold to N. P. Stevens of Concord, N. H., on September 7, 1893. Mr. Stevens used the motor in his machine shop until his death in 1910, when his son closed out the shop and sold the motor to P. C. Shute, Concord, in November of that year. In 1914 the motor was again sold, this time to the Ford Foundry Co. of Concord, from whom it was purchased in March, 1917, by the Page Belting Co., in whose plant it was in service until June 15, 1925.

The motor was in almost continuous service for nearly 32 years, the early years of service being on a 50-cycle circuit. In 1900 the circuit was changed to 60 cycles.

French Engineers to Visit the United States

A delegation of French engineers is preparing to make a six weeks' visit to the United States to study American power-plant practice. They expect to leave Havre on Sept. 23 and to arrive in New York City on Sept. 29. The personnel of the delegation is as follows: Albert Petsche, president of Ste Lyonnaise Des Eaux & De L'Eclairage Union D'Electricite and official of many other companies; Ernest Mercier, president, Cie Francaise Des Petroles and builder of the Gennevilliers power station; Paul Eschwege, vice-president of S. A. Nord Lumiere, and a consulting engineer; Maurice Saurel, president Ste D'Electricite De Strasbourg and director of Thomson-Houston; Albert Malle, president, Societe D'Electricite De Strasbourg; Emile Pinson, director, Cie Continentale Edison, Ste Provinciale D'Electricite; Edmond Aubert, director, Cie Ouest-Lumière; Edouard Imbs, of the Cie Parisienne de Distribution d'Electricite; P. Meunier, director Fusion des Gaz, Union D'Electricite; J. A. Arrighi de Casanova, chief engineer, Union D'Electricite; Rene Hochstetter, general manager Ste Alsacienne De Constructions Mechaniques a Belfort; Edouard Roth, chief engineer, Ste Alsacienne De Constructions Mechaniques a Belfort; Robert De Valbreuze, consulting engineer, Cie Des Lampes; J. F. J. Bethenod, consulting engineer Ste Alsacienne De Constructions Mechaniques; Louis Astier, engineer, Cie Parisienne De Distribution D'Electricite; Louis Joseph Sartre, engineer, Cie Parisienne De Distribution D'Electricite.

These officials and engineers representing the French power interests will visit the large power plants throughout the entire United States, leaving New York for home on November 6.



First G.E. polyphase motor sold in 1893, now in the G.E. Museum.

Great Britain's Output of Electricity Gaining

The Electricity Commission has issued particulars of the generation of electricity in Great Britain for the year ended March 31, 1925. Returns were received in respect of 584 generating stations. The total kilowatt-hours generated amounted to 7,415,375,529, compared with 6,681,524,272 kw.-hr. in the preceding year. The total output thus showed an increase of nearly 734,000,000 kw.-hr., or 11 per cent, whereas the total consumption of fuel showed an increase of 551,797 tons, or 5.8 per cent only.

Water-Hammer Tests To Be Conducted

Tests that will simulate the effect of water hammer will be conducted by the A. O. Smith Corp. on penstock piping at its plant in Milwaukee on Sept. 28. About fifty members of the American Society of Mechanical Engineers and some engineers from power companies on the Pacific Coast will be present to observe the results. Hydraulic pressure will be built up on some of the test piping to a value of 2,000 lb. per sq.in. and will be released and reapplied at the rate of 120 times per minute. Records will be taken and the piping later examined to determine the extent and degree of distortion if any.

Leather Belting Exports Continue Good

The United States exported 720,293 lb. of leather belting, valued at $1,051,478, to various foreign countries during the first seven months of 1925, which was an increase of 27.7 per cent over the quantity exported in the corresponding period of 1924. The increased demand reflects in some measure the more stabilized business conditions abroad.

The July, 1925, exports of leather belting amounted to 128,267 lb., valued at $185,514. Canada, South America, China, British India, Mexico, and Cuba, the leading markets, received respectively 19,248, 18,768, 18,739, 18,115, 13,854 and 11,554 pounds. All these countries show increased trade as compared with that of July, 1924, according to *Commerce Reports*.

Conowingo Hearing Set for October 5

Final argument before the Pennsylvania Public Service Commission in the application of the Susquehanna Power Co. for authority to build a hydroelectric power plant on the Susquehanna River at Conowingo is to be heard on Oct. 5.

The Oil Burner Manufacturers Outline a Technical Program

The American Association of Oil Burner Manufacturers with headquarters at 350 Madison Ave., New York City, has outlined a technical program for the association's activities which briefly is as follows: Establish a data file on everything relating to oil burning, including oils, burners and various equipment; collect and distribute data on the testing of burners, this will give in detail the method for ascertaining "how efficient a heat machine the burner really is"; describe methods for taking flue and stack temperatures and determining the percentage of carbon dioxide present and preparing curves showing the relationship between pounds of oil burned, per cent of carbon dioxide in flue gas, temperature and amount of water evaporated; investigate burner design with reference to obtaining uniform flow to burner and feed to nozzles with special reference to type of screen used; make study of effect of velocity of winds and drafts on efficiency of burners; investigate the installation of economizers or some method of picking up heat that ordinarily goes up the stack; study flame control; investigate efficiency of boilers and possibilities of finding metal to withstand high temperatures; co-operate with the oil industry in collecting data on tests and means of distribution of oils sold for burning; inform, through publications, the oil industry of the problems confronting the burner industry; distribute latest information in regard to oil burners; co-operate with the fire prevention and Underwriters' Laboratories; revise association standards for oil-burning ordinances; continue work on research in radiant heat and its uses for vaporizing oil fuels; better and more practical materials for screens; investigate possibilities of inexpensive liquid, soluble in oil, containing large percentage of oxygen.

Production of Bituminous and Anthracite Coal, 1919-1925

In Thousand Net Tons

Bituminous

	1925	1924	1923	1922	1921	1920	1919
January	51,930	52,464	51,903	38,930	41,148	49,748	42,193
February	38,987	47,262	43,610	42,425	31,524	41,055	32,103
March	37,626	41,253	48,411	51,936	31,054	47,850	34,293
April	33,702	30,404	44,028	16,335	28,154	38,764	32,712
May	35,474	32,248	47,660	21,005	34,057	39,841	38,186
June	37,167	31,433	47,054	23,096	34,635	46,095	37,685
July	39,582	33,317	46,678	17,602	31,047	45,988	43,425
Total 7 months	274,468	268,381	329,344	211,329	231,619	309,341	260,597

Anthracite

	1925	1924	1923	1922	1921	1920	1919
January	7,419	7,924	8,521	6,566	7,681	7,459	7,819
February	7,176	7,621	7,602	7,096	7,983	6,415	5,102
March	7,058	8,114	9,175	9,181	7,677	7,935	5,190
April	7,472	6,811	7,885	27	7,985	6,285	6,884
May	8,134	7,745	8,384	36	7,752	8,037	7,525
June	7,804	7,704	8,474	86	8,071	8,251	7,404
July	8,544	7,782	8,136	118	7,309	8,342	7,974
Total 7 months	53,607	53,701	58,117	23,110	54,458	52,724	47,898

Submarine Cables for Penang

The submarine cables which are to supply Penang, Straits Settlements, with current from the new power station at Prai are said to be the longest submarine power cables that have been manufactured in one length. Each cable is 4½ miles long and consists of 6 conductors, each of 0.075 sq.in. sectional area, forming a three-phase feeder of 0.15 sq.in. sectional area of conductor per phase. They are four inches in diameter, paper insulated, lead sheathed and armored. The total weight of the submarine section is 270 tons. The normal pressure of these feeders will be 12,400 volts, 50 cycles. The test pressure will be 28,000 volts. (Vice Consul Richard Ford, Penang, Straits Settlements.)

Society Affairs

The Chicago Section of the A.S.M.E. will hold its annual get-together meeting on Sept. 23 at the City Club at 6:30 p.m.

The Colorado Section of the A.S.M.E. will make an excursion to the Valmont plant of the Public Service Co. of Colorado on Sept. 26.

The Toledo Section of the A.S.M.E. will hear Dr. William F. Durand speak at a meeting on Sept. 28, which will be held at the Toledo Chamber of Commerce.

The American Welding Society, which will hold its fall meeting during the week of the exposition of welding at the Massachusetts Institute of Technology, Cambridge, Mass., Oct. 21-23, will have a paper of interest to *Power* readers: "Gas Welding of Power Plant Piping."

The Administrative Board of the American Engineering Council will be held in Columbus, Ohio, Oct. 29-30, under the auspices of the Engineers' Club of Columbus. The president of the Council, former Governor James Hartness of Vermont, who has been recovering from a prolonged illness, is expected to preside.

The American Association of Engineers' Board of Directors at a meeting on Sept. 12, in accordance with the demands of members as expressed in a referendum recently taken, has revised the basic structure of the association with regard to separating national and local dues, elimination of grades of membership, undertaking a nation wide survey of supply and demand of engineers to be carried on in co-operation with other national bodies, an enlarged placement service.

The Colorado Engineering Council, comprising the Colorado sections of the national engineering societies and of local societies, has agreed to aid Denver in an advisory manner, without cost to the city. The feasibility of any proposed work by the city will be given due consideration and its practicality passed on, free of cost, but any drawing of plans and specifications is to come under the regular order of work to be paid for. The Colorado Engineering Council was organized in 1919.

Personal Mention

Walter J. Hughes has left the Wayne Tank & Pump Co., of Fort Wayne, Ind., and is now with the International Filter Co. at Chicago, Ill.

Dr. Herbert B. Dwight has been added to the professional staff in the electrical engineering department of the Massachusetts Institute of Technology.

Hugo Diemer, vice-chairman of the Chicago Section of the A.S.M.E., has just been elected president of the Chicago chapter of the Society of Industrial Engineers.

R. W. Morton resigned as engineer with the Leavitt Manufacturing Co., Urbana, Ill., on Aug. 29, to become instructor in mechanical engineering at the Colorado School of Mines, Golden, Colo.

Herbert C. Hill has been appointed head of the Western and Southwestern divisions of the generating department of the Edison Electric Illuminating Co. of Boston. He succeeds Harry B. Bullen, who died on June 2 of this year.

Jos. B. Verdon, who for the past four and one-half years has been chief engineer of the Chateau Frontenac Hotel, Quebec, has resigned his position to join the Quebec Provincial Government's Industrial Department, as boiler inspector and stationary engineers' examiner.

Dr. Oskar von Miller, director of the Deutsches Museum von Meisterwerken der Naturwissenschaft und Technik of Munich, Germany, left on Sept. 8 for an extended visit to Mexico. He expects to spend the month of November in a visit to the United States.

Dr. William F. Durand, president of the A.S.M.E. and member of the National Advisory Committee for Aeronautics, has been appointed by the President, and is now secretary, to the board recently created to inquire into the whole aviation policy of the country.

Frank G. Philo, who for the past six years has been engaged mainly in preliminary operation of power stations for Stone & Webster, Inc., on Sept. 1 became associated with the Southern California Edison Co., as assistant superintendent of steam power generation. Mr. Philo will make his headquarters at the Long Beach Steam Plant No. 2.

Business Notes

The Reading Iron Co., Reading, Pa., announces that G. H. Woodroffe has been appointed metallurgical engineer, a newly created position in the boiler tube department.

The Leavitt Machine Co., Orange, Mass., manufacturer of valves, valve gates and reseating machines for globe valves, announces the appointment of the following representatives: The Ernest E. Lee Co., 115 South Dearborn St., Chicago, Ill.; Halverson Engineering Co., Lumber Exchange Bldg., Minneapolis, Minn.; Atlas Machinery & Supply Co., 1407 Pine St., St. Louis, Mo.; Acme Engineering Agency, 312 Traction Terminal Bldg., Indianapolis, Ind.

The Foote Bros., Gear & Machine Co., 215 N. Curtis St., Chicago, Ill., announces that W. McNamee, formerly with the Holt Manufacturing Co., has been appointed district representative for Indiana and part of Illinois, with headquarters in the Chicago office.

Coming Conventions

American Electric Railway Association. James W. Walsh, 8 West 40th St., New York City. Convention and exhibits at Young's Million Dollar Pier, Atlantic City, N. J., Oct. 5-9.

American Electrochemical Society. Dr. Colin G. Fink, Columbia University, New York City. Convention at Signal Mountain Hotel, Chattanooga, Tenn., Sept. 24-26.

American Society of Civil Engineers. George T. Seabury, 29 West 39th St., New York City. Fall meeting at Montreal, Oct. 14-16.

American Society of Mechanical Engineers—Calvin W. Rice, 29 West 39th St., New York City. Annual meeting at New York City, Nov. 30-Dec. 3.

American Society of Refrigerating Engineers, William H. Ross, 154 Nassau St., New York City. Annual meeting at New York City, Nov. 30-Dec. 3.

American Welding Society. M. M. Kelly, 33 W. 29th St., New York City. Fall meeting and Exposition of Welding Equipment and Accessories at the Massachusetts Institute of Technology, Cambridge, Mass., Oct. 21-23.

Association for the Advancement of Science. Burton E. Livingston, Smithsonian Institution, Washington, D. C. Annual meeting at Kansas City, Dec. 28, 1925, to Jan. 2, 1926.

Association of Edison Illuminating Companies. Preston S. Miller, 80th St. and East End Ave., New York City. Annual meeting at New Arlington Hotel, Hot Springs, Ark., Oct. 19-23.

Chemical Industries. Tenth Exposition at Grand Central Palace, New York City. Sept. 28-Oct. 3.

Eastern Ice Manufacturers Association. W. H. Ross, 35 Warren St., New York City. Convention at Atlantic City, Nov. 23-25.

Electric Power Club, S. N. Clarkson, B. F. Keith Bldg., Cleveland, Ohio. Fall meeting at Briarcliff Manor, N. Y., Oct. 19-22.

Empire State Gas & Electric Association. C. H. B. Chapin, 5618 Grand Central Terminal Bldg., New York City. Meeting at Lake Placid Club, N. Y., Oct. 1 and 2.

Midwestern Engineering Exposition, Inc. George E. Pfisterer, 53 West Jackson Boulevard, Chicago, Ill., general manager. Exposition and power show to be held in Chicago, Jan. 26-30, 1926.

National Association of Practical Refrigerating Engineers, Edward H. Fox, 5707 West Lake St., Chicago, Ill. Sixteenth annual convention and educational exhibition at Statler Hotel, Detroit, Mich., Dec. 8-12.

National Exposition of Power & Mechanical Engineering. Fred W. Payne and C. F. Roth, Managers, Grand Central Palace, New York City. Exposition at Grand Central Palace, Nov. 30-Dec. 5.

National Safety Council. G. H. Cameron, 168 North Michigan Ave., Chicago, Ill. Fourteenth Annual Safety Congress at Cleveland, Ohio, Sept. 28-Oct. 2.

The Chicago-Wilcox Manufacturing Co., which is the name for the consolidated firms of the Chicago Gasket Co. and the Wilcox Manufacturing Co., manufacturers of gaskets, packing, etc., is now located at its new and enlarged plant E. 77th St. and Anthony Ave., Chicago, Illinois.

Trade Catalogs

Pipe and Valves Repair Tools—The M. B. Skinner Co., 558 Washington Boulevard, Chicago, Ill., has recently issued a rotogravved descriptive circular "We Keep Plants Running," describing the operation of its clamps and tools used for pipe repair, valve reseating and steam specialties.

Coal-Handling Machinery — Gifford-Wood Co., Hudson, N. Y., manufacturer of elevating and conveying machinery. Catalog No. 725, "Coal Dealers Machinery and Supplies," is a well-illustrated description of the wagon loaders, portable flight conveyors, portable belt conveyors, portable bagging hoopers, electric capstan car pullers, wagon chutes, rotary screens, yard screens, scoops, bags, etc., manufactured by this company.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; *mine run* except Pittsburgh gas slack:

Bituminous, Net Tons	Market Quoting	Sept. 14 1925
Pool 1	New York	$2.75@$3.00
Smokeless	Boston	2.66
Clearfield	Boston	1.65@ 2.10
Somerset	Boston	1.75@ 2.25
Kanawha	Columbus	1.55@ 1.85
Hocking	Columbus	1.50@ 1.80
Pittsburgh	Pittsburgh	2.00@ 2.15
Pittsburgh gas slack	Pittsburgh	1.50@ 1.60
Franklin, Ill.	Chicago	2.25@ 2.50
Central, Ill.	Chicago	2.00@ 2.25
Ind. 4th Vein	Chicago	2.25@ 2.50
West Ky.	Louisville	1.25@ 1.50
S. E. Ky.	Louisville	1.50@ 1.75
Big Seam	Birmingham	1.50@ 2.00
Anthracite, Gross Tons		
Buckwheat No. 1	New York	$2.50@$3.00
Buckwheat No. 1	Philadelphia	2.50
Birdseye	New York	1.60

FUEL OIL

New York—Sept. 17, light oil, tank-car lots; 28@34 deg. Baumé, 5¼c. per gal., 36@40 deg. 5¼c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Sept. 3, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.75 per bbl.; 26@28 deg., $1.80 per bbl.; 28@30 deg., $1.85 per bbl.; 30@32 deg., $1.90 per bbl.; 32@36 deg., gas oil, 5c. per gal.; 38@40 deg., 5.7c. per gal.

Pittsburgh—Sept. 8, f.o.b. local refinery; 30@34 deg., fuel oil, 5c. per gal.; 36@40 deg., fuel oil, 6c. per gal.

Dallas—Sept. 12, f.o.b. local refinery 26@30 deg., $1.65 per bbl.

Philadelphia—Sept. 14, 27@30 deg., $2.15@$2.21 per bbl.; 18@22 deg., $1.848@$1.908; 13@19 deg., $1.575@ $1.635 per bbl.

Boston—Sept. 14, tank-car lots, f.o.b. heavy oil, 12@14 deg. Baumé, 4¼c. per gal.; light oil, 28@32 deg. Baumé, 5¼c. per gal.

Cincinnati—Sept 15, tank-car lots, f.o.b. local refinery, 24@26 deg., Baumé, 5¼c. per gal.; 26@30 deg., 5⅝c. per gal.; 30@32 deg., 5⅝c. per gal.

Chicago—Sept. 15, tank-car lots, f.o.b. Oklahoma, freight to Chicago 92c. per bbl.; 24@26 deg., $1.10 per bbl.; 30@32 deg., $1.25.

New Plant Construction

Calif., Altadena (Pasadena P. O.)—Boys & Girls Aid Society, is having plans prepared for the construction of a 4 story orphanage including a power plant. Estimated cost $300,000. M. Hunt, 1107 Hibernian Bldg., Los Angeles, is architect.

Calif., Los Angeles—J. H. Jonas, 5841 Park Ave., is having plans prepared for the construction of a 5 story factory and 2 story mill including loading platforms, 3 electric freight elevators, etc. at 5843 South Park Ave. Estimated cost $325,000. Stromwell & Halperin, 1007 South Grand Ave. are architects.

Fla., Auburndale—Auburndale Ice & Cold Storage Co., H. H. Abee, Pres., is in the market for ice and cold storage machinery.

Ill., Chicago—J. Morton, 80 East Jackson St., is having plans prepared for the construction of an 18 story office building at Wells and Washington Sts. Graham, Anderson, Probst & White, 80 East Jackson St., are architects.

Ill., Chicago—Syndicate, 340 North Dearborn St., is having plans prepared for the construction of a 12 story hotel at Surf St. and Sheridan Road. Estimated cost $2,000,000.

Ill., Peoria—B. L. Hulsebus, 1232 Jefferson Bldg., Archt., is receiving bids for the construction of a 7 story warehouse and cold storage plant including the installation of a power plant, for Central Warehouse & Cold Storage Co. Owner is in the market for refrigeration machinery. F. A. Randall, 160 North La Salle St., Chicago, is engineer.

Ill., Peoria—Standard Oil Co., R. Allen, 910 South Michigan Ave., Chicago, Consulting Engr., is receiving bids for the construction of a boiler house, pump house, oil storage yard, etc. here. F. A. Randall, 160 North La Salle St. is engineer. W. Gauger, 36 West Randolph St. is architect.

Ia., Burlington—Iowa Southern Utilities Co., Centerville, awarded contract for the construction of a power plant here to Nebergall & Sons. Estimated cost $200,000.

Ia., State Center—City plans an election Sept. 23 to vote $25,000 bonds for improvements to waterworks including pumping station, tank on tower, etc. Brown & Cook, Ottumwa, are engineers.

Kan., Osborne — Salina Poultry Co., Salina, awarded contract for the construction of a poultry and cold storage plant here, to W. E. Johnson & Sons, Salina. Estimated cost $30,000.

Kan., Salina—Northwest Kansas Methodist Episcopal Conference, c/o C. Shaver, Archt., plans the construction of first unit 4 story hospital. Estimated cost $500,000.

Mass., Brookline (Boston P. O.)—Tudor Associates, 263 Harrison Ave., Boston, is having plans prepared for the construction of an 8 story apartment at 1442 Beacon St. here. Estimated cost $500,000. Whitten & Gore, 31 Milk St., Boston, are architects.

Mich., Detroit—Bd. of Water Comrs., G. H. Fenkell, Gen. Mgr., 176 East Jefferson Ave., will receive bids until Oct. 13th for furnishing one 50,000,000 and one 75,000,000 gal. capacity motor driven centrifugal pumps against a 170 ft. head.

Mich., Detroit—Public Lighting Comn., J. S. Foley, Secy., 174 East Atwater St., will receive bids until Sept. 28 for furnishing and installing electric switching and control equipment for new municipal power plant switch house and switching stations A, B, C, and D. Bids were opened and contracts will soon be awarded for the construction of the superstructure for power plant including turbine house, conveyor, bridge and transformer house, boiler house, etc., on Morrell St. Smith, Hinchman & Grylls, 800 Marquette Bldg., are engineers.

Mich., Detroit—Weston & Ellington, 1507 Stroh Bldg., Archts., are preparing plans for the construction of a 12 story hotel including steam heating system. Estimated cost $900,000. Owners' name withheld.

Mich., Port Huron—City has had plans prepared for the construction of a sanitary sewage system including pumping station, for North End. E. R. Whitmore, City Hall, is engineer.

Mich., Plymouth—Wayne County, 1103 Real Estate Exchange Bldg., Detroit, awarded contract for the construction of a pump house, well, sewage system, etc. at Plymouth Road and Pere Marquette Ry. here to Liberty Construction Co., 1026 Detroit Savings Bank Bldg., Detroit. $50,284.

Minn., Cloquet—City is having plans prepared for the construction of a waterworks system including pumping equipment, etc. Estimated cost $15,000. J. A. Parks is city clerk.

Minn., Red Wing—City plans the installation of a 750 gal. capacity motorized pump. Estimated cost $11,000.

Miss., Clinton—City will receive bids until Sept. 27th for a deep well, 150 g.p.m. pumps, etc. Estimated cost $17,500.

Mo., St. Louis — Local Syndicate, c/o Weisels-Gerhart Real Estate Co., 8th & Chestnut Sts., plans the construction of a 20 story theatre, office and stores building at 11th and Pine Sts. Estimated cost $5,000,000.

Mo., Warrensburg — Roseland Farm & Mfg. Co., awarded contract for the construction of a 2 story cold storage plant to C. L. Johnson. Estimated cost $45,000.

Neb., Omaha—B. Kulp & Associates, 3158 West Madison St., Chicago, Ill., awarded contract for the construction of a 17 story office building at 17th and Dodge Sts. here to Seldon-Breck Construction Co., Arthur Bldg. Estimated cost $2,000,000.

N. Y., Brooklyn—Danett Realty Co., c/o Seelig & Finkelstein, 44 Court St., Archts., is having plans prepared for the construction of a 14 story hotel on West 5th St. Estimated cost $1,000,000.

N. Y., Brooklyn—Shampan & Shampan, 188 Montague St., Archts., are preparing plans for the construction of two 6 story apartments on East 18th St. Estimated cost $500,000, each. Owners' name withheld.

N. Y., Mount Vernon—Van Lahric Corporation, c/o McKim, Mead & White, 101 Park Ave., New York City, Archts., awarded contract for the construction of 10 apartment buildings on East Lincoln Ave. here to Van Evelyn Corporation, 407 5th Ave., New York. Estimated cost $640,000 each.

N. Y., New York—Fifteen West Forty Seventh Street Corporation, c/o W. M. Mason, Grand Central Terminal, Archt., is having plans prepared for the construction of an 18 story office building on West 47th St. Estimated cost $1,000,000.

N. Y., New York—J. Fishman & Sons, Inc., 280 Madison Ave., plans the construction of a 14 story apartment at Park Ave. and 19th St. Estimated cost $300,000. Schwartz & Gross, 347 5th Ave., are architects and engineers. Owner builds by separate contracts.

N. Y., New York—J. Golding & Bros., 225 West 88th St., plans the construction of a 25 story hotel on Central Park West. Estimated cost $6,000,000. Architect not selected.

N. Y., New York—H. Hemingway, c/o R. Candela, 200 West 72nd St., Archt., plans the construction of a 15 story apartment on East 56th St. Estimated cost $1,000,000.

N. Y., New York—N. Minskoff, 2382 Grand Concourse, plans the construction of a 15 story apartment at 119 West 72nd St. Estimated cost $1,500,000.

N. Y., New York—Mt. Sinai Hospital, 5th Ave. and 101st St., is having plans prepared for the construction of a nurses' school at 5th Ave. and 98th St. Estimated cost $1,500,000. R. D. Kohn, 56 West 45th St., is architect and engineer.

N. Y., New York — New York State Bridge & Tunnel Commission and New Jersey Interstate Bridge & Tunnel Commission, 3004 Woolworth Bldg., will receive bids until Oct. 6th for furnishing and installing 18 horizontal centrifugal and 1 triplex pumps including motors and control, 4 horizontal centrifugal booster pumps complete. The centrifugal pumps range in capacity from 100 to 1,000 g.p.m. with total heads up to 200 ft.

N. C., Greensboro—J. E. Latham, et al, awarded contract for the construction of a 13 story hotel to The Foundation Co., 120 Liberty St., New York, N. Y. Estimated cost $1,300,000.

O., Cleveland—Ohio Farmers Co-Operative Milk Co., R. N. Strong, Pres., 3068 West 106th St., awarded contract for the construction of a boiler house and alterations to dairy, to Van Blarcom Co., National City Bldg. Estimated cost $100,000.

O., Columbus—City, H. C. Cain, Secy. Bd. of Purchase, will soon receive bids for 13 various size transformers.

O., Columbus—J. P. McCune, Dir. of Safety, is in the market for motor generator and charging set for division of fire and police telegraph. Estimated cost $1,000.

O., Macedonia—City Council plans the construction of an electric distribution plant. Estimated cost $25,000.

Okla., Blackwell—City, W. H. Clarke, Purch. Agt., is in the market for a new 750 kw. steam turbine generator set for municipal electric light plant.

Okla., Chandler — City, M. D. Gray, Mayor, plans an election soon to vote $150,000 bonds for improvements to waterworks system including pumping equipment, mains, etc. Holway Engineering Co., 503 Wright Bldg., Tulsa, is engineer.

Okla., Frederick—City plans the construction of a new 1,000,000 gal. reservoir including pumps, two deep wells, etc. Benham Engineering Co., 512 Gumbel Bldg., Kansas City, Mo., is engineer.

Okla., Henrietta—City plans an election soon to vote $200,000 bonds for improvements to waterworks including a pumping station, filtration plant, mains, etc. Holway Engineering Co., 503 Wright Bldg., Tulsa, is engineer.

Okla., Tonkawa—City is having preliminary plans prepared for the construction of a 3 unit 1,000 hp. Diesel oil engine electric light plant. Estimated cost $150,000.

Tenn., Knoxville—Dooley-Gillespie Realty Co., Deaderick Blvd., is having preliminary plans prepared for the construction of a 17 story hotel. Estimated cost $1,500,000. A. B. Bauman, is architect.

Tex., Beaumont—East Texas Electric Co., awarded contract for the construction of a 3,000 kw. power plant to Stone & Webster, 147 Milk St., Boston, Mass. Estimated cost $3,000,000. T. R. Thornburg, is construction superintendent.

Tex., Beaumont—Jefferson County, B. B. Johnson, County Judge, will receive bids until Sept. 28th for operating machinery for Naches River bridge.

Tex., Eagle Lake — Industrial Cotton Mills, plans the construction of a textile mill including power plant. Estimated cost $150,000.

Tex., Holland—Geyser Ice Co., Waco, plans the construction of a 15 or 20 ton ice plant here. Estimated cost $25,000. Engineer not selected.

Tex., Houston—Rice Hotel Co., c/o N. E. Meadows, Pres., awarded contract for the construction of a 17 story addition to hotel at Texas Ave. and Travis St. to G. W. Hewitt, 2230 Commerce St., Dallas. Estimated cost $700,000.

Tex., Palacios—U. S. Government, War Dept., Lt. Col. L. Westbrook, will build a government training camp including a power house, refrigeration plant, laundry, etc., probably by day labor. Estimated cost $500,000 to $1,000,000.

Tex., San Antonio — J. K. Tobin, T. W. Carver and R. F. McCampbell, 550 East Mitchell St., are having plans prepared for the construction of an ice skating rink including a 70 ton refrigeration plant. Estimated cost $105,000. Private plans. Owner will purchase equipment for refrigerating plant.

Va., Amherst—W. A. Baldock, plans the construction of a hotel and ice manufacturing plant to supply town and nearby communities. Will probably install a water supply system.

Wis., Kenosha—Bd. of Education, E. Powers, Secy., awarded contract for the construction of a boiler house for Central high school to Madsen & Peterson, 646 Builders' Exchange, Minneapolis, Minn., $77,386.

Wis., Kewaskum—S. N. Casper, Clk., is having plans prepared for the installation of a 50 g.p.m. sewage pump, against a 10 ft. head. J. Donohue Engineering Co., 608 North 8th St., Sheboygan, is engineer.

Ont., Niagara Falls—Shredded Wheat Co., plans extensions to factory and boiler house. Estimated cost $50,000. A. Costello, c/o owner, is engineer.